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Mine Permit Number M045OO17 Mine Name Mercur Mine
Operator BARRICK Resources Date April 26, 1982
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Application to Approval to Construct Reservation Canyon Tailing Dam

__NOI __Incoming __Outgoing __Internal __Superceded

__NOI __Incoming __Outgoing __Internal __Superceded

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__TEXT/ 81/2 X 11 MAP PAGES __11 X 17 MAPS __LARGE MAP

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M/045/017



Application for Approval to Construct
Reservation Canyon Tailings Dam

**Getty Mining Company**

Made to
State Engineers Office

GEOTECHNICAL REPORT

TAILINGS DAM

RESERVATION CANYON

MERCUR GOLD PROJECT

Prepared for:

GETTY MINING COMPANY

TOOELE, UTAH

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# 1.0 INTRODUCTION

## 1.1 SUMMARY

This report documents the geotechnical design of a 270 foot high embankment to retain tailings at Reservation Canyon. It covers the site's geological and seismicity studies, subsurface and laboratory investigation, embankment design criteria, and site hydrology. This dam is located within 4000 feet of the old town of Mercur, Tooele County, Utah, within the Mercur Gold Project Area.

The design life of the Pond is 12 years. One million cubic yards of tailings will be deposited during the first year, and 0.8 million per year during the remaining 11 years. The total impoundment volume will be 9.8 million cubic yards. The embankment shall be constructed in stages to minimize initial capital investment. Its final height shall be 270 feet. The Stage I embankment will store two years of operation. Stage II will hold a total capacity of 5.8 million cubic yards. Stage III completes the storage capacity to a total of 9.8 million cubic yards.

Topographical characteristics dictate the need for constructing a saddle dam north of the left abutment of the main dam. Foundation materials for the main dam consist primarily of a colluvium deposit of silty sand and limestone fragments ranging in size to large boulders. A thin

1.0 INTRODUCTION (cont'd)

bed of clay is also found in the right abutment, downstream from the centerline of the dam. Overlayed by the colluvium is a limestone formation. This rock is fractured and jointed having a high permeability. The only exception is in the upstream foundation area where the Manning Canyon shale outcrops instead of the limestone. The contact between limestone and shale has been studied in some detail using borings, seismic refraction, and geologic mapping. No foundation investigation has been performed for the saddle dam. Consequently, its final position and design is subject to a possible change depending on foundation conditions. The saddle dam will have an ultimate height of 85 feet. Except for its smaller size, the final design cross-sections of the saddle dam is expected to be identical to that of the main dam. Its construction will be staged following the same scheme outlined for the main dam. The same criteria have been applied for the design of both dams.

The embankment design consists of a zoned embankment with an upstream inclined core shown in Figure 15. The 1.5 to 1 upstream slope will consist of sandy to clayey gravel with boulders and cobbles. The core material is composed of broken-down Manning Canyon shale and clay from the impoundment area. Figure 6 shows the borrow area for the

1.0 INTRODUCTION (cont'd)

core material. Filter materials shall be borrowed from outside the project area; and shall possess characteristics specified in Appendix A of this report. The downstream shall consists of sandy to clayey gravel with boulders and cobbles. The downstream slope shall be protected from erosion by a 10 foot wide strip of rockfill having a maximum particle size of 1 foot. The downstream slope shall be 2 horizontal to 1 vertical.

Hydrologically, the site is in a semi-arid area. Annual evaporation exceeds annual precipitation. The Probable Maximum Precipitation, PMP, for a duration of 24-hours is 10.5 inches, and was determined using data from the U.S. Water Bureau. Based on the PMP, the PMF, Probable Maximum Flood, was determined. The embankment is designed to store one-half of the PMF. This is conservative because its probability of exceedence over a period of 12 years is less than 1.12%. No diversion ditches are planned for precipitation runoff, since the dam will always have enough freeboard to impound runoff.

Construction of intermediate stages will be started in time to maintain, at all times, sufficient freeboard to store, safely, runoff from the design storm.

1.0 INTRODUCTION (cont'd)

Seismically, the area of the site is in an area of high seismic risk. The primary fault zone is the Wasatch Fault. This fault is considered capable of generating a magnitude 7.5 earthquake. However, it has not produced any significant earthquake (M = 5 to 5.5) during the last 133 years -- the period of historical earthquake records. If this earthquake were to originate on the Wasatch Front (the fault segment closest to the site), the focal distance would be approximately 35 kms.

Another fault of concern is the West Mercur Fault located at the mouth of Mercur Canyon four miles west of the site. Examination of the fault scarp indicates that it has been formed by events of approximately magnitude 7 (21).

Limit equilibrium slope stability analysis has been performed to check the embankment stability against rotational slides under end of construction conditions and for full reservoir conditions under both static and earthquake loadings.

A seismic coefficient of 0.1g was used in pseudo-static earthquake analysis. Details of the analysis are summarized in Section 7.

## 1.0 INTRODUCTION (cont'd)

A simplified deformation analysis was performed to evaluate approximate permanent displacement due to a magnitude 7.5 earthquake originated at the Wasatch Fault and a magnitude 7.0 earthquake originated at the West Mercur Fault. Based on these analyses, we estimate deformations of the order of 1 foot for the Wasatch earthquake and 3 feet for the West Mercur earthquake. These displacements can be tolerated by the dam structure without complete failure since seismic resistant features (e.g. relatively wide filters and core) have been included in design.

A monitoring program will be implemented to monitor movement and pore pressures during construction and operation. Should any anomaly be detected, the design shall be checked under the unexpected conditions, and remedial measures taken, if needed. This program shall be directed by a qualified geotechnical engineer.

### 1.2 Site Location and Description

The proposed tailings impoundment facility is located in the northeast quarter of Section 5 in Township 6 South, Range 3 West, Salt Lake Base and Meridian. This site is an unpopulated drainage basin 5 miles west of Cedar Fort and 4 miles south of Ophir, the closest towns. The impoundment area is to occupy Reservation Canyon, a

1.0 INTRODUCTION (cont'd)

seasonal drainage course just northeast of the abandoned town of Mercur, as shown on Figure 1. The embankment will be constructed across a narrow section of the canyon. In the vicinity of the embankment, the canyon walls are moderately steep with maximum slopes being on the order of 1.5 horizontal to 1.0 vertical. At elevation 7260 feet (maximum dam elevation) the canyon width is approximately 1250 feet. The impoundment area essentially consists of the head of Reservation Canyon where the drainage course widens and divides into a system of relatively small, individual drainages. At its maximum projected elevation, the impoundment area occupies approximately 70 acres. Two relatively low saddle areas are noted along the northern and southern perimeters of the impoundment area. The minimum elevation of the northern saddle area is approximately 7368 feet, while the southern saddle has a minimum elevation of 7207.5 feet.

Vegetation within the area generally consists of a moderate growth of brush and small trees.

## 2.0 DESIGN CRITERIA

### 2.1 Scope

These design criteria establishes the basic parameters for the design and permit submissions for the Mercur Gold Project tailings dam and associated structures, located at Reservation Canyon.

### 2.2 Design Life

The design life for the active tailings pond will be 12 years. The required storage volume was specified by Getty Mineral Resources as:

1 million cubic yards for the first year

0.8 million cubic yards for each of the remaining years

9.8 million cubic yards of tailings will be impounded by the end of operation.

### 2.3 Regulatory Requirements

Permits are required for the construction of the Mercur Gold Project tailings dam. Approval of plans and specifications for the tailings dam construction will be processed through tne following Utah State Agencies:

Utah Department of Natural Resources

Utah Department of Health

## 2.0 DESIGN CRITERIA (cont'd)

The Submission to the Department of Natural Resources will cover their requirements for:

Review of the tailings dam design, slope stability, safety, and long term monitoring, as well as construction plans, specifications and construction control through the Division of Water Rights, Office of the State Engineer.

The submission to the Department of Health will cover their requirements for review of the tailings dam and impoundment design with regard to possible discharge of pollutants to the environment (ground water and air). This review will be carried out by the Bureau of Water Pollution control.

Final reclamation plans have been approved prior to the preparation of this document by the Division of Gas, Oil, and Mining.

### 2.4 Hydrology

| | |
|---|---|
| The storage capacity of each stage of the dam will accommodate 1/2 the volume of the Probable Maximum Flood, PMF, in addition to the tailings storage. | Office of State Engineer |

No spillway will be provided for the embankment.

## 2.0 DESIGN CRITERIA (cont'd)

The PMF will be determined from the 24-hr.

Probable Maximum Precipitation, PMP.

PMP = 10.5 inches — US Weather Bureau
10 year 24 hour storm
precipitation = 1.78 in.

### 2.5 Embankment Design Criteria

#### 2.5.1 Embankment Construction:

The embankment will be constructed in the following stages:

Stage I - The embankment shall be capable of safely storing 1.8 million cubic yards of tailings.

Stage II - The embankment shall be capable of safely storing 5.0 million cubic yards of tailings.

Stage III - This completes the embankment. The total capacity is 9.8 million cubic yards of safely stored tailings.

#### 2.5.2 Embankment Freeboard:

Each stage of the embankment shall be designed to include freeboard to store the design flood plus 1.5 times the wave height plus an additional 4 ft. to account for crest damage due to frost penetration and safety factor. Freeboard is defined as the vertical distance between the crest of the dam and the normal operating pool level.

## 2.0 DESIGN CRITERIA (cont'd)

### 2.5.3 Embankment Settlement:

The embankment settlement is estimated as 0.8 percent of its total design height. Consequently, allowance shall be made for this expected settlement during construction, particularly during the final stage.

### 2.5.4 Impervious Core Thickness

The core width, at any depth, shall be 25 to 40 percent of the design water head above it. The actual thickness will depend on the availability, quality, and cost of the core material.

### 2.5.5 Filter Design Criteria:

1. The particle size, D15, of the filter material shall be at least five times as large as the D15 size of the soil being protected by the filter. (D15 is the particle size coarser than the finest 15% of the soil or filter.)

2. The D15 size of the filter shall not be larger than five times the D85 size of the protected soil.

3. The gradation curve of the filter shall be specified to have approximately the same shape as the gradation curve of the protected soil.

2.0 DESIGN CRITERIA (cont'd)

4. Wherever the protected soil contains a large percentage of gravel, the filter will be designed on the basis of the gradation curve of the portion of the material which is finer than a No.4 United States Standard sieve.

5. Filters shall contain less than 5% of fines passing the No. 200 sieve, and the fines shall be cohesionless. A greater percentage of cohesionless fines may be permitted if permeability tests show that the filter material is sufficiently pervious to transmit all of the seepage discharge within the filter zone.

6. The D50 size of the filter should be less than 25 times the D50 size of the protected soil.

7. Darcy's law will be utilized to determine the required filter permeability.

8. Wherever slotted pipes are used in drainage systems, the following criteria shall apply to protect the filter particles from clogging the pipe:

$$\frac{D85F}{\text{Slot width}} = 1.2$$

## 2.0 DESIGN CRITERIA (cont'd)

### 2.5.6 Design Earthquake:

An examination of known active faults and historical earthquakes in a 200 mile radius of the site will be used to determine the magnitude of the design earthquake and the value of the maximum ground acceleration at the foundation rock (competent rock). The study will be based on data available in the literature.

The selection of a Seismic Coefficient for Pseudo-static Analysis will be based on the design earthquake magnitude. The seismic coefficient will be assigned in accordance with the following criteria (13) provided the maximum crest acceleration is less than 0.75g:

| | |
|---|---|
| For M = 6-1/2 | = 0.1 g |
| For M = 8-1/4 | = 0.15 g |

### 2.5.7 Blasting Effects:

Limits on future blasting (charge per delay), near the dam site, will be set to limit induced ground accelerations to values that will not damage the embankment.

### 2.5.8 Stability Analysis:

The following design conditions will be considered:

1. Static stability at the end of construction.
2. Pseudo-static stability at the end of construction.
3. Static stability during the design flood at the end of operation.

2.0 DESIGN CRITERIA (cont'd)

4. Static stability during normal operating conditions at the maximum normal pool level.

5. Pseudo-static stability during normal final operating conditions.

The allowable factor of safety for each case will be:

| Case | Safety Factor |
|---|---|
| 1 | 1.3 |
| 2 | 1.15 |
| 3 | 1.4 |
| 4 | 1.5 |
| 5 | 1.15 |

The above values for the factor of safety may be modified later if increased knowledge of site conditions and/or embankment material properties warrants it. In general, the pseudo-static stability analysis should be used only as a guide and greater weight shall be given to the deformation analysis required under paragraph 2.5.10.

The design shall consider a zoned embankment, and the tailings impounded in the reservoir. The tailings shall be assumed to be liquified during the design earthquake.

2.5.9 Liquefaction Potential

Dry materials and well compacted coarse grained clayey materials are highly resistant to liquefaction even under high magnitude earthquakes (M = 6.5 to 7.5).

2.0 DESIGN CRITERIA (cont'd)

2.5.10 The Newmark (10) method of analysis as modified by Franklin and Chang (6) will be used to determine approximate earthquake induced deformations due to the design earthquake.

2.5.11 Confirmatory dynamic response analysis shall be performed if:

(a) There is considerable evidence from the seismicity study that an earthquake of magnitude greater than 7 should be postulated for design.

(b) If foundation conditions or embankment material properties produce concern for excessive deformations under the design earthquake.

2.5.12 Location of the Phreatic Line

The phreatic line will be determined assuming an anisotropic ratio (horizontal to vertical) of permeability of 9 for the core material (4). The filter and shell materials will be assigned a ratio of 15. Permeability values will be determined by appropriate laboratory testing.

## 3.0 GEOLOGY

### 3.1 Regional Geology

The proposed dam site in Reservation Canyon is located in the southern Oquirrh Mountains, a generally north-south trending range approximately 30 miles long by 6 to 12 miles wide. This mountain range is in the eastern portion of the Basin and Range structural province, west of the Wasatch Range and east-southeast of the town of Tooele, Utah. Figure 1 shows the generalized surface geology of the site.

### 3.2 Stratigraphy

The bedrock in the vicinity of the dam site includes Paleozoic and Mesozoic limestones, quartzites and shales and Eocene igneous rocks.

The principal geological units exposed at the site are the upper Great Blue Limestone, the Manning Canyon Shale and the basal Oquirrh Formation. The upper Great Blue Limestone (Mgbu) (upper Mississippian) consists of a monotonous 2750 foot thick sequence of massive bedded, medium gray, dark grey and blue grey, aphanic to finely crystalline limestones which overlie the medial Long Trail shale member (2). This is in turn overlain by the Manning Canyon Shale (MPmc) (Mississippian-Pennsylvanian), a black, thinly bedded, recessive carbonaceous to calcareous shale with interbedded limestone and quartzite. The

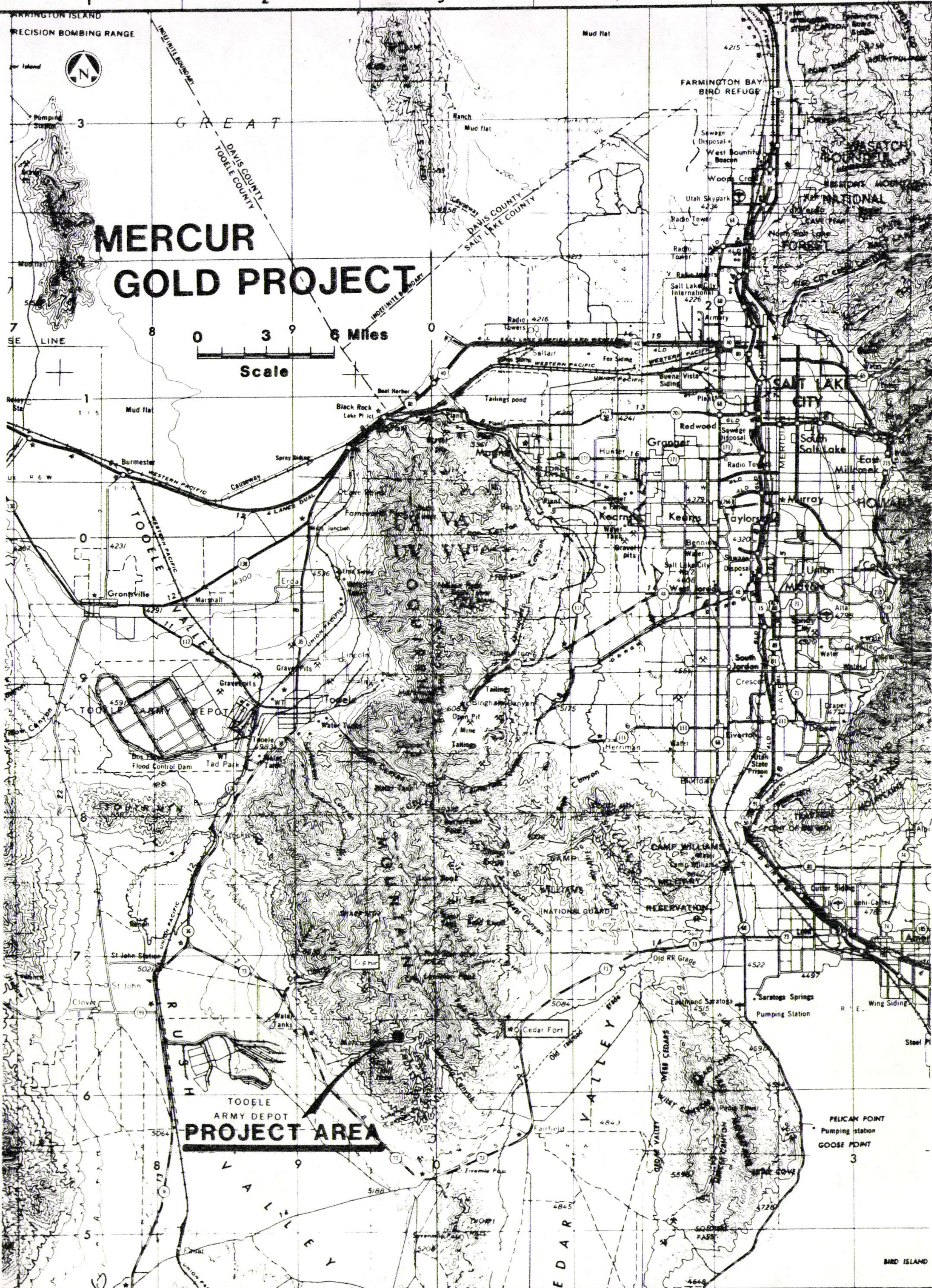


FIGURE 1

| | |
|---|---|
| CLIENT | MERCUR GOLD PROJECT<br>TOOELE COUNTY<br>GETTY MINING COMPANY<br>Salt Lake City, Utah |
| | Davy McKee<br>DMC Engineers and Constructors<br>San Mateo, California |
| TITLE | RESERVATION CANYON<br>TAILINGS DISPOSAL DAM<br>LOCATION MAP |
| DRAWING No. | SC 2385 A<br>80-22-001<br>SHEET 1 OF |

| NO. | DESCRIPTION | BY | CH. | APPROVED | DATE |
|---|---|---|---|---|---|
| A | ISSUED FOR APPROVAL | | | | 2-2-62 |

| | BY | DATE |
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| DESIGNED | | |
| DRAWN | | |
| CHECKED | | |
| APPROVED 1 | Uh. | 12-9-82 |
| APPROVED 2 | | |
| APPROVED 3 | | |

| DATE TO | |
|---|---|
| CLIENT | 7/ |
| FIELD | CC-12-74 |
| MICROFILM | |

DRAWING NO. 80-22-001

GAF Polytrace 044

3.0 GEOLOGY (cont'd)

average thickness of the Manning Canyon shale is 1500-1600 feet (9). It is gradationally overlain by the Hall Canyon member of the Oquirrh Formation (Phc) (Pennsylvanian), which consists of approximately 900 feet of dark to medium brown-grey bioclastic and crystalline limestones with local orthoquartzites.

Igneous rocks in the Mercur area include stocks, sills and dikes of granodioritic to rhyolitic compositions emplaced during early Tertiary time. The nearest igneous rock, the Eagle Hill rhyolite porphyry, crops out about one mile south of the dam site.

3.3 Structure

During Laramide deformation (approximately 65 million years ago) the sedimentary strata were folded into a series of large, generally north-northwest trending anticlines and synclines. The proposed dam site is situated on the eastern flank of the Ophir Anticline, approximately 1.9 miles east-northeast of the fold axis. The Pole Canyon Syncline fold axis lies east of the dam site.

Some faulting observed in the area is attributed to the Laramide folding (12). Other faults evident in the area are associated with the Eocene igneous activity. The third and most significant fault system developed in the area is the Basin and Range structural deformation.

## 3.0 GEOLOGY (cont'd)

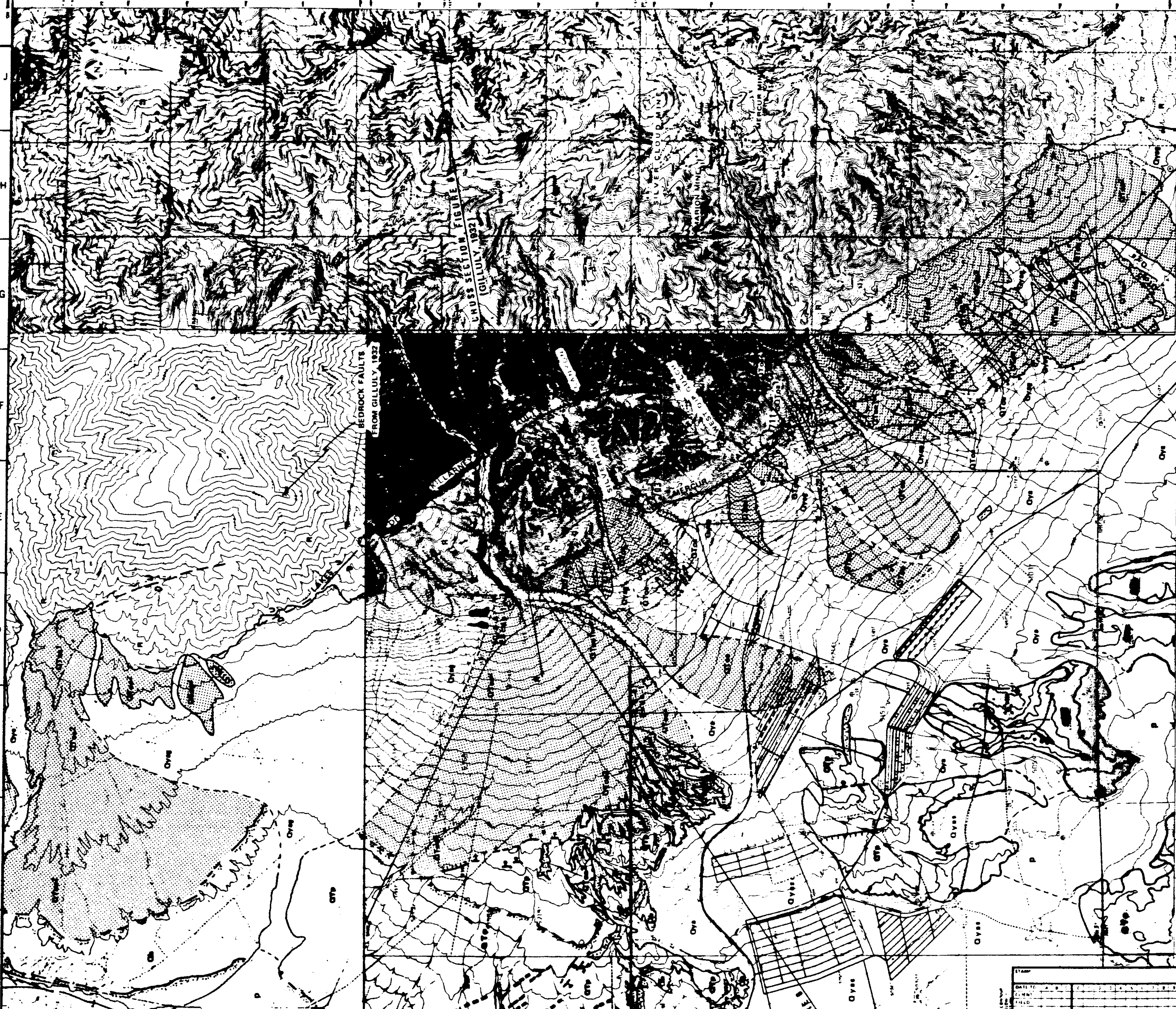
The main phase of normal faulting of the Basin and Range structural deformation began in Miocene time. The West Mercur fault which forms the western boundary of the Oquirrh Mountains and is located approximately 4 miles south 70 degrees west of the dam site, is related to this event. Both the West Mercur Fault and the Wasatch fault, located parallel to and east of the West Mercur fault, exhibit evidence of recent seismic activity (5, 6, 7). See Figure 2.

### 3.4 Local Geology

Preliminary geologic mapping of the dam site was done by Woodward Clyde Consultants (23) in November and December, 1981. See Figure 3.

The majority of the proposed dam footprint in Reservation Canyon will overlay the upper Great Blue Limestone. At this location, the upper Great Blue is a hard, strongly jointed rock with open partings along bedding planes (19). The average bedding strike is north 22 degrees west with an average dip of 45 degrees north. The dominant joint orientation is a northeasterly strike with a vertical dip.

The southeast side of the dam footprint and most of the proposed reservoir is underlain by the Manning Canyon Shale. The contact between the Great Blue Limestone and




Special Study 51

# PLATE III b

Northern Rush Valley, Tooele County, Utah

## EXPLANATION

SURFACES

P — Playa: flat, featureless, poorly drained unvegetated plains of silt or clay, mostly marginal to the Great Salt Lake below the historic high water contour of [illegible] feet, and in the [illegible] of Rush Valley

pc — Historic playa washover channels, sec. 9 & 10, T1S, R6W

UNCONSOLIDATED DEPOSITS

Qmt — Modern mill tailings

Qya — Post-Lake Bonneville alluvium: mostly very thin sheets of sand or silt; boulder mudflow deposits near mountain fronts; shoreline features of the underlying Qb are obscured. 5-15 feet in thickness.

Qyag — Sand-gravel facies

Qyas — Silt-clay facies

Dunes or features modified by wind drift; those near present lake level are composed of calcareous oolitic sand, sometimes with a core of lake silt; up to 15 feet in thickness

UNCONSOLIDATED TO PARTLY CONSOLIDATED DEPOSITS (Plio-Pleistocene)

Qb — Lake Bonneville shore deposits (Bonneville Group): mostly a thin veneer of gravel, sand, and silt, on which shoreline features are visible. Deposits of unconsolidated to weakly cemented gravel up to 200 feet thick occur primarily at the Bonneville shoreline (5200 to 5250 feet elevation), the Provo shoreline (4800 to 4850), and the Stansbury shoreline (4400 feet).

Qbg — Sand-gravel facies 0 to 200 feet thick

Qbs — Clay-silt facies 0 to possibly 100 feet thick

QToa — Older (pre-Lake Bonneville) alluvium, ranging from coarse rounded gravel near mountain footslopes to sand and silt toward basin centers; locally cemented by caliche or travertine; exposed mostly above the Lake Bonneville shoreline; thicknesses are not well known but range to 500 feet in some areas, and may extend to 1000 feet in parts of Tooele Valley. Superscripts 1, 2, 3, indicate local relative age of remnants, where locally separable by age.

QTp — Pediments cut on Salt Lake group rocks and capped with a veneer (5 to 30 feet) of QToa.

UNCONSOLIDATED TO CONSOLIDATED DEPOSITS (Tertiary)

Tsl — Tertiary Salt Lake group: conglomerate, sandstone, siltstone, limestone, and tuffaceous deposits of estimated Miocene and Pliocene age. A section more than 8000 feet thick is exposed in Rush Valley (Heylmun, 1963). Some unconsolidated gravel, sand, and silt at depth in Tooele Valley is also of Salt Lake age

CONSOLIDATED DEPOSITS

R — Bedrock pre-dating the major period of Basin & Range Formation (Eocene & older).

OTHER SYMBOLS

Fault showing displacement of Quaternary surfaces, ball on downthrown side, dashed where inferred

Beach cliff (line) and shore platform (dots)

Scarp of erosional or undetermined origin

Bedrock normal fault, with direction of offset indicated.

Vegetation lineation of possible tectonic origin

Geologic boundary, dashed where inferred or approximately located

703 — Field location with identification number

Location of selected wells and boreholes.

Sources.

The base map was mosaicked and reduced from U.S. Geological Survey 7½' and 15' topographic quadrangles.

Most of the area was mapped from 1953 U.S. Army 1:63,000 aerial photography (VVASH 15 to 21 AMS). A strip along the OFT fault zone was mapped in greater detail from 1959 U.S. Department of Agriculture 1:20,000 aerial photography (CYO), including parts of townships 7 & 8 south, Ranges 3 & 4 west on map IIIc, and parts of Townships 5 & 6 south, Ranges 4 & 5 west on map IIIb.

Selected bedrock faults are shown as mapped by Gilluly, 1932, Groff 1959, and Moore and Sorensen, 1978.

Parts of map IIIa were adapted from Tooker & Roberts, 1971, Geologic maps of the Garfield and Mills Junction Quadrangles, and from Davis, F. D., 1978, Surficial geology of western Bingham Canyon and Tooele 7½' Quadrangles, unpublished manuscript, UGMS

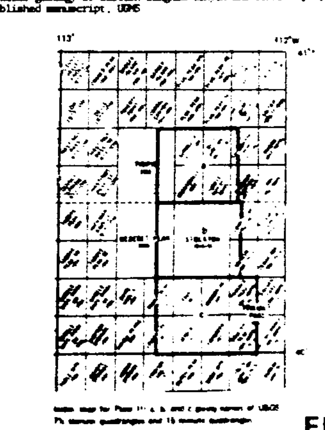
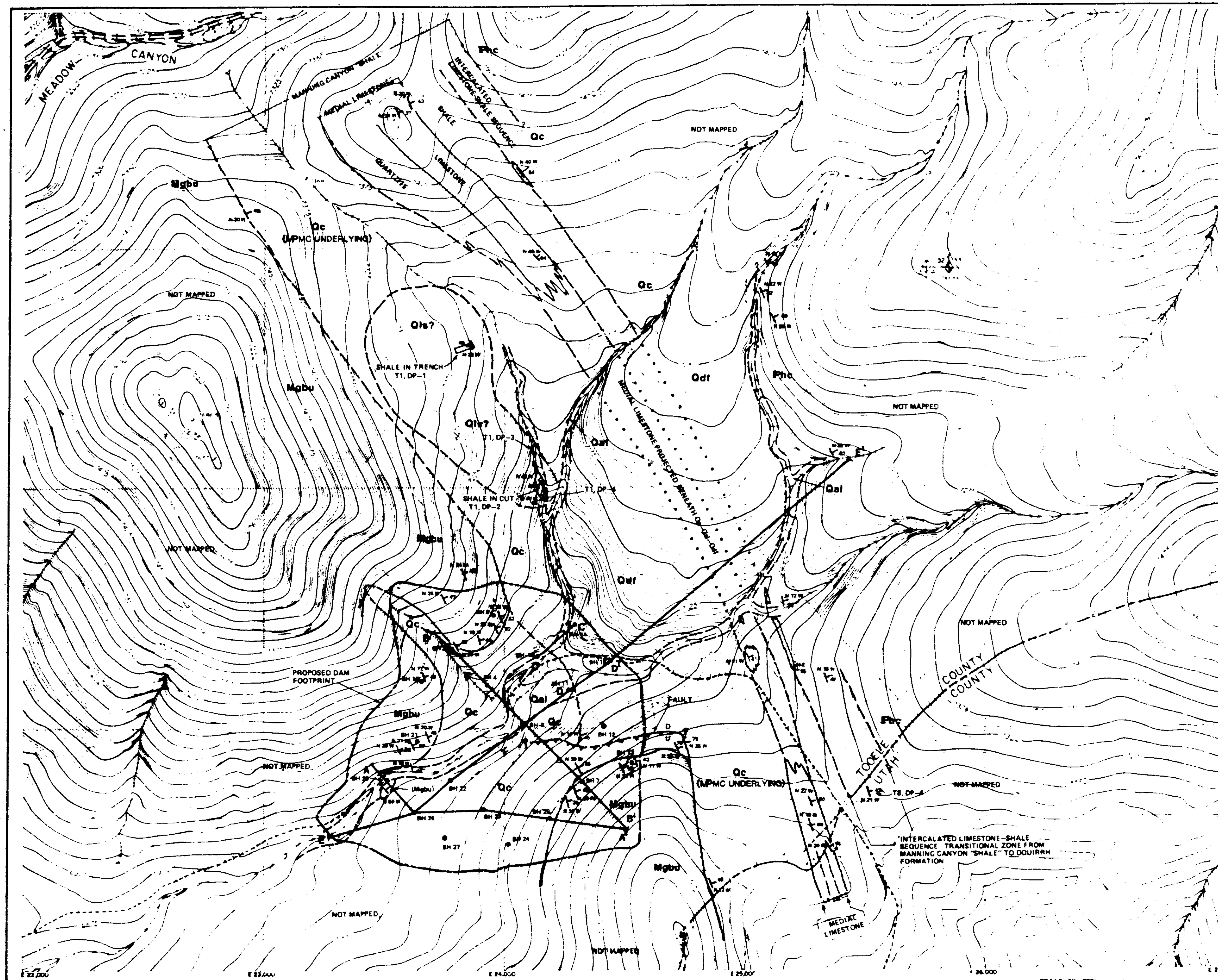


FIGURE 2

MERCUR GOLD PROJECT
GETTY MINERAL
RESOURCES COMPANY
Salt Lake City, Utah

Davy McKee
DMC Engineers and Constructors

GENERAL SURFICIAL GEOLOGY
RUSH VALLEY & MERCUR




## SEDIMENTARY ROCKS

QUATERNARY
- Qal ALLUVIUM
- Qdf DEBRIS FLOW
- Qc COLLUVIUM
- Qls LANDSLIDE

UNCONSOLIDATED DEPOSITS
~~~ UNCONFORMITY ~~~

PENNSYLVANIAN
- Phc OQUIRRH FM HALL CANYON MEMBER

MISSISSIPPIAN
- MPMC MANNING CANYON SHALE
- Mgbu GREAT BLUE LIMESTONE (UPPER MEMBER)

## GEOLOGIC SYMBOLS

- OUTCROP
- STRIKE AND DIP
- LITHOLOGIC CONTACT
- CONCEALED CONTACT
- PROJECTED OR INFERRED (DEEPLY BURIED) CONTACT
- FAULT; D INDICATES DOWNTHROWN SIDE, U INDICATES UPTHROWN SIDE. BARBS INDICATE DIRECTION OF DIP. QUERIES INDICATE THAT PROJECTION OF FAULT IS UNKNOWN AND SPECULATIVE.
- A–A' GEOLOGIC CROSS SECTION INCLUDED IN REPORT (See Figure 3)

## ABBREVIATIONS

- LS LIMESTONE
- SH SHALE
- T TRAVERSE
- DP DATA POINT
- BH BOREHOLE

| A-1 | A-2 |
|---|---|
| A-3 | A-4 |
| A-5 | A-6 |
| A-7 | A-8 |
| A-9 | |

SHEET INDEX

SCALE 1" = 200'

0 100 200 400 600 800 feet

FIGURE 3

**PRELIMINARY GEOLOGICAL MAP**

RESERVATION CANYON DAM SITE
MERCUR GOLD PROJECT
Tooele County, Utah

Project No. 15141D

**Woodward-Clyde Consultants**
~~~

3.0 GEOLOGY (cont'd)

the Manning Canyon Shale is defined on the basis of calcareous shale being the dominant rock type over dark blue-grey limestones. The shale unit is a valley-former and the majority of it is covered by colluvium and/or alluvium. Secondary calcite and quartz stringers are evidence of hydrothermal alteration. The strike and dip of this unit is variable although in general is similar to that of the Great Blue Limestone. This variability of dip may be explained by increased deformation during folding resulting from the location of the shale between two thick and competent limestone strata.

Interbeds of limestone and quartzite exist within the Manning Canyon Shale. One such medial sequence, 100 to 400 feet thick, was identified within the reservoir area (23). Most of the site is covered by colluvium and/or alluvium. The colluvium is generally rocky whereas the alluvium is finer grained. These unconsolidated deposits range in thickness from 10 to 20 feet on the slopes beneath the proposed dam abutment to 20 to 80 feet along the valley floor. A maximum thickness of 102 feet was encountered at one test site (19).

A 50 to 60 foot thick heterogeneous, rock debris deposit covers a major portion of the reservoir floor.

3.0 GEOLOGY (cont'd)

## 3.5 Local Faulting

Within Reservation Canyon, strong linears are evident on an aerial photograph of the area. A probable explanation of these generally east-west trending, subparallel features is that they represent fault zones.

One of these fault zones crosses the dam foundation area, according to Woodward-Clyde investigations, putting the Manning Canyon "in fault contact with the Great Blue Limestone beneath part of the upstream toe area" (19).No openings were observed in the fault zone but "the true nature and extent of the fault . . . is still poorly known", (23).This shall be clarified during the foundation excavation.

These inferred faults are transverse to the trend of the potentially active faults in the region (Wasatch and West Mercur), i.e. they do not appear to be part of the same fault system. Their orientation is more analagous to faults associated with the Laramide deformation.

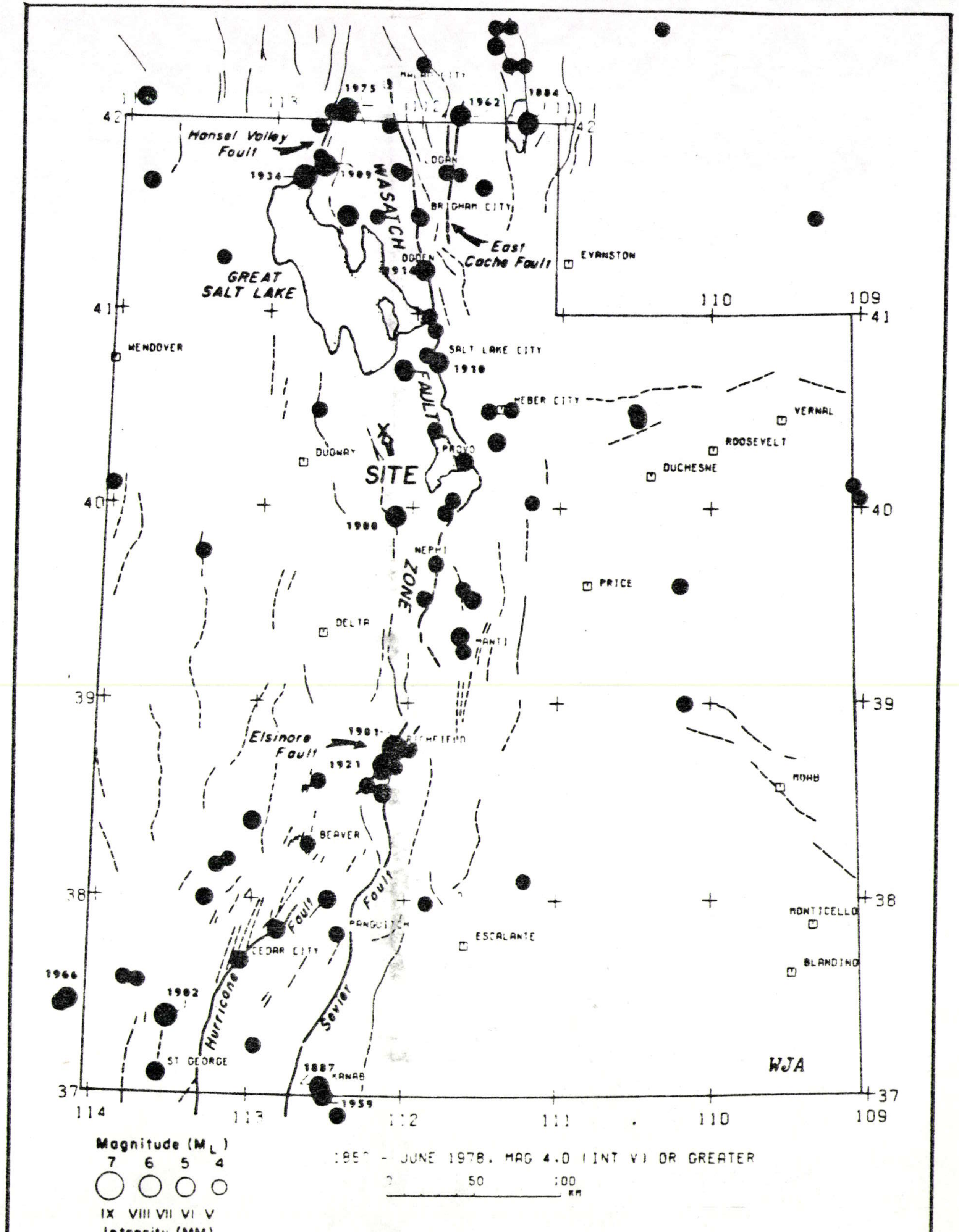
# 4.0 SEISMICITY AND FAULTING

## 4.1 Active Faults and Seismic History.

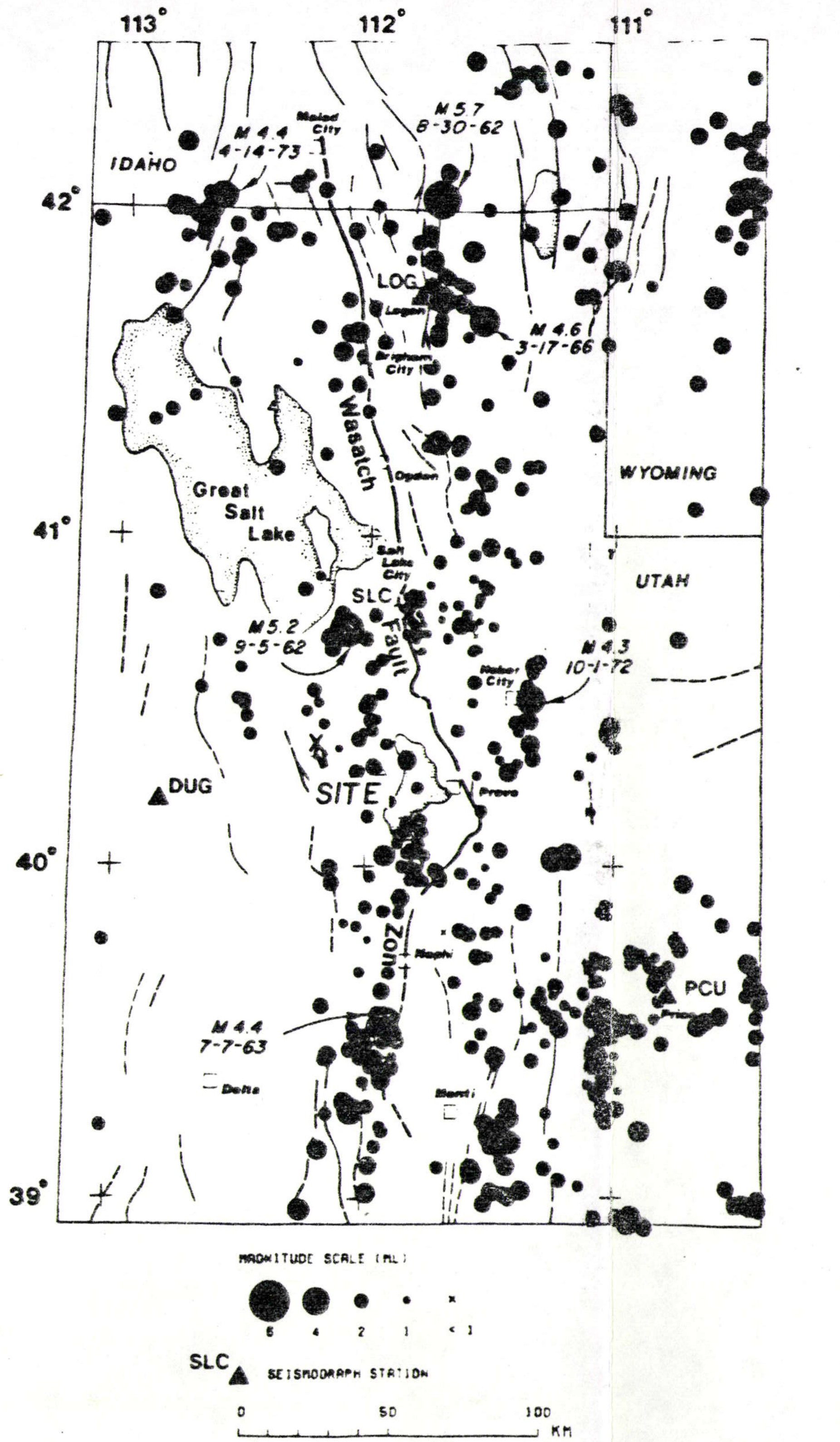
The site area lies along the western edge of the Intermountain Seismic Belt, a north-trending zone of seismicity interpreted as the boundary between two subplates of the North American Plate. The belt extends along the boundary between the Rocky Mountain and the Colorado Plateau physiographic provinces on the east and the Basin and Range physiographic province to the west from southwestern Utah to the Canadian border.

In the Utah area, the Intermountain Seismic Belt is delineated by a series of active fault zones. The primary fault zone in this area is the 370-mile long Wasatch fault which extends from Gunnison, Utah, northward to Malad City, Idaho. The Wasatch fault passes through Salt Lake City along the geologic break referred to as the Wasatch Front. Other active fault zones in the Utah area included the Hansel Valley fault to the north and the Sevier, Hurricane and Elsinore fault systems to the south. The general seismicity of these fault zones is demonstrated by concentration of earthquake epicenters presented on Figure 4. A list of earthquakes which may have affected Tooele and Rush Valleys is shown in Table 1.

In the immediate dam site area, the largest seismic events include a magnitude 5.2 earthquake which occurred near Magna, Utah (approximately 20 miles to the north) on September 5,




EPICENTER MAP OF THE LARGEST HISTORICAL EARTHQUAKES IN THE UTAH REGION, 1850-1978




WASATCH FRONT EQ'S : JULY 62 TO SEPT. 74

# EARTHQUAKE EPICENTERS

FIGURE 4

**Dames & Moore**

REFERENCE:
EARTHQUAKE STUDIES IN UTAH, 1850 TO 1978, EDITED BY WALTER J. ARABASZ, ROBERT B. SMITH, AND WILLIAM D. RICHINS, PREPARED AS A SPECIAL PUBLICATION OF THE UNIVERSITY OF UTAH SEISMOGRAPH STATIONS, JULY 1979.

REVISIONS
BY ______ DATE ______ TO EO ______
BY ______ DATE ______ TO EO ______

BY ______ DATE ______
CHECKED BY ______
COPY TO EO ______

TABLE 1. CHECK LIST OF EARTHQUAKES
Which May Have Affected the Tooele & Rush Valleys

| Date | Local Time | Epicentral Location | Epicentral Intensity (MM) | Felt Area, Sq. Mi. | Description |
|---|---|---|---|---|---|
| 8-01-00 | 00-45 | Eureka | VII | <1,000 | Slight damage in epicentral area (Deseret News) |
| 10-05-09 | 19-50 | Hansel Valley | VII | 30,000 | Buildings out of plumb at Saltair; waves washed over Lucin Cutoff (Deseret News) no mention (Tooele Transcript-Bulletin) |
| 5-22-10 | 07-28 | Salt Lake City | VII | <1,000 | "Salt Lake rocked by earthquake" -- no mention of local effect (Tooele Transcript Bulletin). |
| 8-11-15 | 03-20 | Stansbury Range | V | <1,000 | No mention (Tooele Transcript-Bulletin). |
| 10-02-15 | 23-56 | Pleasant Valley, Nev. | X | 30,000 | "Earthquake in Nevada" - - no mention of local effect (Tooele Transcript-Bulletin). |
| 3-12-34 | 08-06 | Kosmo | IX | 170,000 | No mention of Tooele, slight damage in Grantsville (Tooele Transcript-Bulletin, 3/16/34); intensity V with slight damage in Tooele (Neumann, 1936) |
| 11-18-37 | 09-50 | Lucin | VI | <1,000 | Not mentioned in Tooele Transcript-Bulletin |
| 6-30-38 | 06-37 | Magna | V | <1,000 | No mention, Tooele Transcript-Bulletin |
| 12-01-58 | 13-51 & 20-23 | Clover ? (Probably Nephi) | V | <1,000 | No mention, Tooele Transcript or Bulletin |
| 9-05-62 | 09-04 | Magna | VI | <1,000 | "Another quake shakes ---" felt locally but no damage (Toole Transcript); no mention (Tooele Bulletin). |
| 9-23-67 | | Magna | V | <1,000 | No mention, Tooele Transcript |
| 3-27-75 | 08-31 | Pocatello Valley | VII | - | No mention (Tooele Transcript or Bulletin) |

SOURCES: Rogers and others, 1976; Richins, 1979; Williams and Tapper, 1953; Neumann, 1936; Deseret News; Tooele Transcript and Tooele Bulletin and their successors.

4.0 SEISMICITY AND FAULTING (cont'd)

1962; a magnitude 5.5 event which occurred near Eureka, Utah (approximately 50 miles to the south), August 1, 1900; and a 4.2 event which occurred in the Stansbury Mountains. The largest recorded seismic event which has occurred in the Salt Lake City area was a magnitude 5.5 event occurring on May 22, 1910 (5).

The closest potentially active fault is the West Mercur fault, four miles southwest of the dam site. See Figure 3. This is a "range front" fault caused by west-trending extensional stresses during the past few million years. Evidence of quaternary surface faulting (5) suggests at least two fault movements between 12,000 and 6000 years ago. After review of aerial-photography and other geological and seismological data, Woodward Clyde Consultants concluded that no appreciable movement has occurred during the last 2000 years. The return period for this fault is estimated at about 5000 to 6000 years.

The Wasatch fault has been studied recently (3, 17). Results from these studies indicate that this fault is capable of producing a magnitude 7.5 earthquake during a maximum estimated return period of 430 years. These results are based on detailed geological and seismological work and are not substantiated by recent historical data. There has been no earthquake of significant magnitude (M = 5 to 6) generated by the Wasatch fault over the last 133 years, the period of documented seismic history.

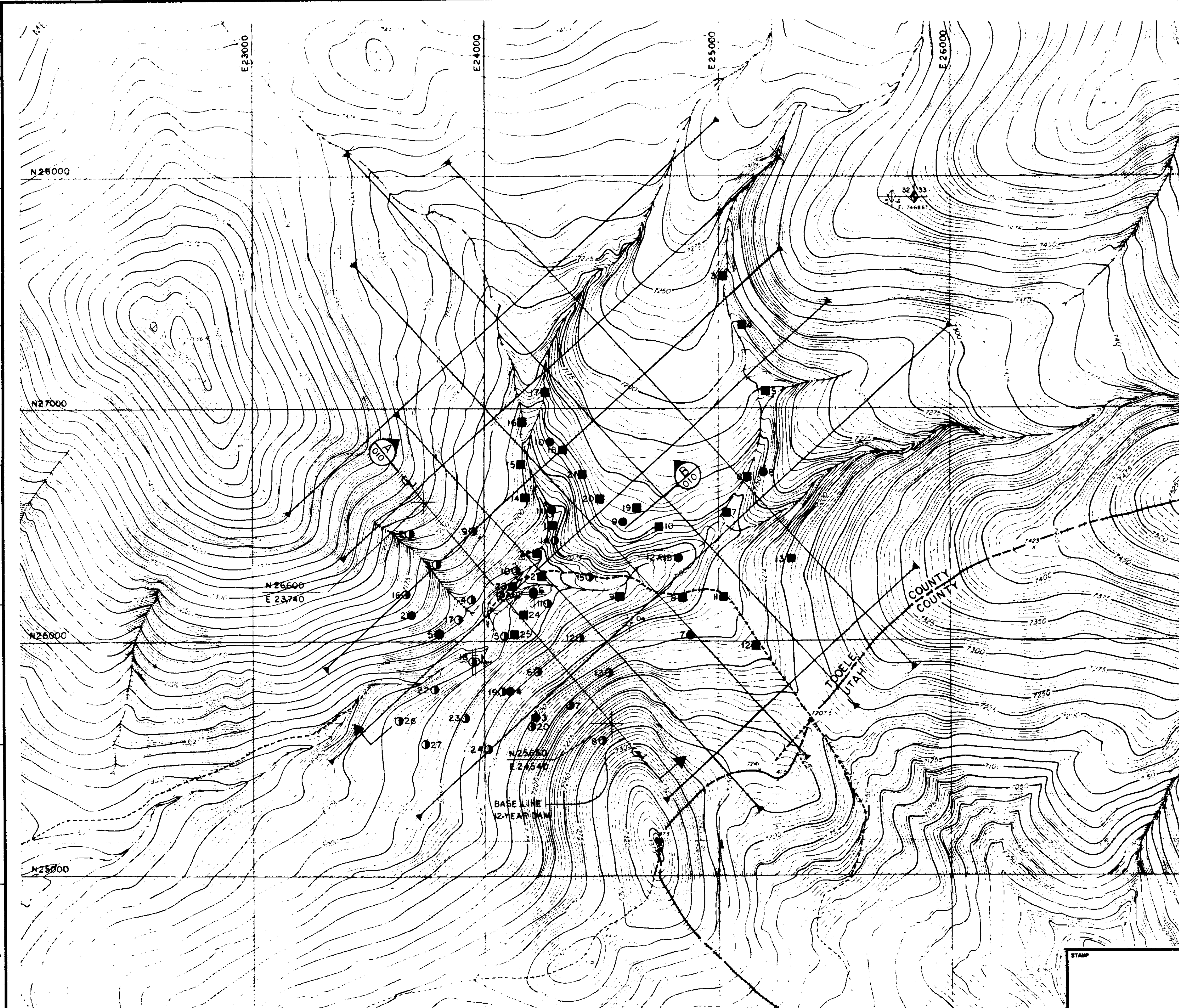
### 4.2 Design Earthquakes

As a result of reviewing the seismic data for this region, two possible sources of critical seismic loading are postulated for the purpose of earthquake analysis:

A magnitude 7.5 earthquake generated by the Wasatch fault. The epicentral distance is 34 kms. This fault dips 60 degrees to the southwest, the focal depth is approximately 10 kms, the focal distance is approximately 35 kms, and the closest distance to the fault scarp is 40 kms.

A magnitude 7.0 earthquake generated by the West Mercur fault. This fault dips about 60 degrees to the southwest, the focal depth is approximately 10 kms, and the focal distance is about 15 kms. The epicenter is about 11 kms from the dam (20). and the closest distance to the fault scarp is 6.4 kms.

Of the two faults, the Wasatch fault has the shorter return period. Hence, it is the most likely to produce an earthquake in the near future.




## NOTES

1. CONTOURS REPRODUCED FROM TOPOGRAPHIC MAP DATED AUGUST 1981 BY AAA ENGINEERING AND DRAFTING INC. SALT LAKE CITY, UTAH
2. SEE WOODWARD AND CLYDE "BASIC GEOTECNHICAL DATA REPORT RESERVATION CANYON DAM SITE MERCUR GOLD PROJECT TOOELE COUNTY, UTAH" DATED JANUARY 15, 1982 FOR BORE HOLE AND SEISMIC LINE DATA
3. SEE DAMES AND MOORE "SEEPAGE AND CONTAMINATION CONTROL EVALUATION, RESERVATION CANYON TAILINGS DISPOSAL AREA, MERCUR GOLD PROJECT, MERCUR UTAH FOR GETTY MINERAL RESOURCES COMPANY," DATED NOVEMBER 1981

## LEGEND

- SEISMIC LINE WOODWARD AND CLYDE
- TEST PIT DAMES AND MOORE
- BORE HOLE DAMES AND MOORE
- BORE HOLE WOODWARD AND CLYDE

FIGURE 5

| NO. | DESCRIPTION | BY | CH. | APPROVED | DATE |
|---|---|---|---|---|---|
| A | ISSUED FOR APPROVAL | | | | 2-1-82 |
| A | ISSUED FOR BID | | | | |

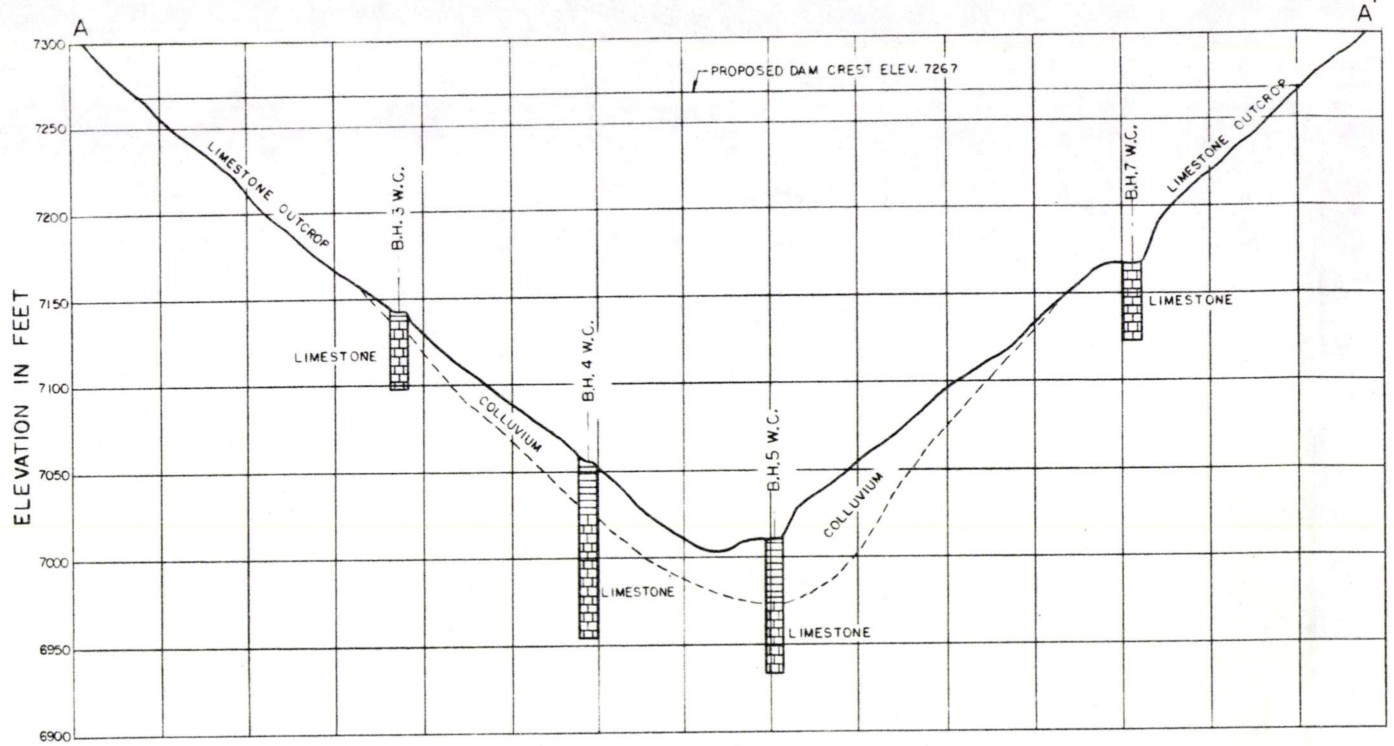
CLIENT: MERCUR GOLD PROJECT
TOOELE COUNTY
GETTY MINING COMPANY
Salt Lake City, Utah

Davy McKee
DMC Engineers and Constructors
San Mateo, California

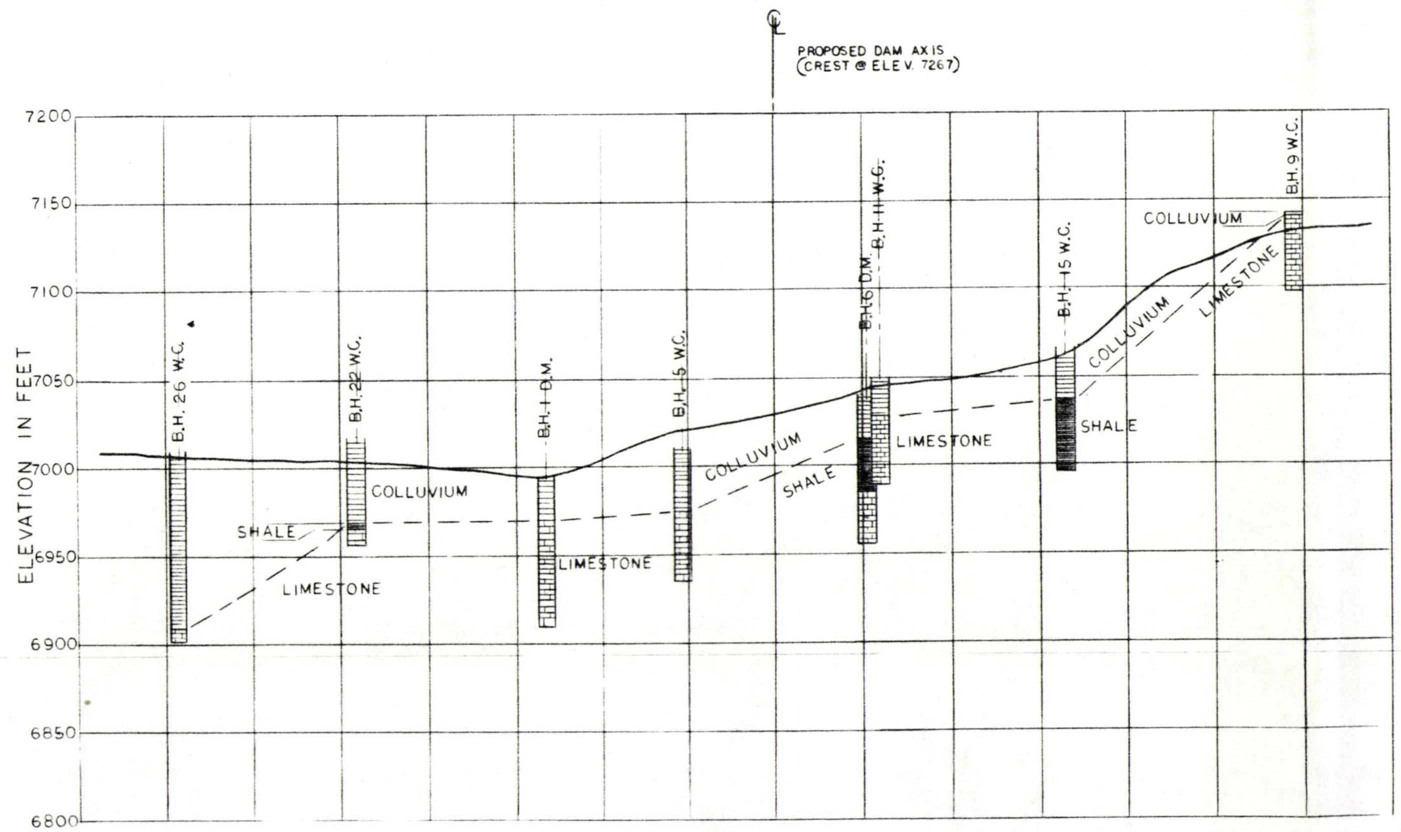
TITLE: RESERVATION CANYON TAILINGS DISPOSAL DAM SUBSURFACE INVESTIGATION

DRAWING No. SC 2385A
80-22-009
SHEET OF
REVISION B

DRAWING NO. 80-22-009




SECTION (A/009)
SCALE: HORZ. 1"=100'




SECTION (B/009)
SCALE: HORZ. 1"=100'

NOTES:

1.) THE SOIL-ROCK PROFILE HAS BEEN CONSTRUCTED FROM BORINGS PERFORMED AND REPORTED BY WOODWARD-CLYDE CONSULTANTS AND DAMES & MOORE AND FROM SEISMIC REFRACTION LINES PERFORMED BY WOODWARD-CLYDE CONSULTANTS.
2.) FOR APPROXIMATE BORING LOCATIONS SEE DRAWING 80-22-009

LEGEND:

B.H. 2 W.C. INDICATES: BORE HOLE NUMBER 2 BY WOODWARD-CLYDE CONSULTANTS
B.H. 2 D.M. INDICATES: BORE HOLE NUMBER 2 BY DAMES & MOORE

FIGURE 5A

| NO. | DESCRIPTION | BY | CH. | APPROVED | DATE |
|---|---|---|---|---|---|
| A | ISSUED FOR APPROVAL | | | | |
| B | ISSUED FOR BID | | | | 8/12/82 |

| | BY | DATE | DATE TO | |
|---|---|---|---|---|
| DESIGNED | | | CLIENT | |
| DRAWN | EG | 12-8-81 | FIELD | |
| CHECKED | | 1-29-82 | | CC-12 4/4 |
| APPROVED 1 | | | MICROFILM | |
| APPROVED 2 | | | | |
| APPROVED 3 | | | | |

CLIENT: MERCUR GOLD PROJECT
TOOELE COUNTY
GETTY MINING COMPANY
Salt Lake City, Utah

**Davy McKee**
DMC Engineers and Constructors
San Mateo, California

TITLE: RESERVATION CANYON TAILINGS DISPOSAL DAM SUBSURFACE PROFILES

DRAWING No. SC2385A
80-22-010
SHEET OF
REVISION E

DRAWING NO. 80-22-009

GAF Polytrace 044

## 5.0 FIELD INVESTIGATION

A field investigation has been implemented to gather data on:

a) Impoundment foundation conditions

b) Embankment foundation conditions

c) Characterization of borrow material, sources, and their availability in adequate quantities and quality.

The investigative techniques used and their purpose are listed in Table 2.

The field work was carried out by:

1) Dames and Moore (4) - who performed a preliminary investigation of the embankment foundation, and a detailed geotechnical characterization of the impoundment area. Details of this investigation are shown in Table 3.

2) Woodward Clyde Consultants (18, 19, 21, 22) - who executed a program devised by Davy McKee Corporation. This program included geological and geophysical investigations of the embankment and impoundment areas. In addition, 17 borings were drilled in the embankment area. Details of the borings are found in Table 3.

A plan view showing test pits and borings performed for the subsurface investigation is shown in Figure 5. Typical cross-sections are shown in Figure 5A. Figures 6A and 6B show geologic mapping of borrow areas for core and shell materials. Details of the subsurface investigation work are shown in the following reports:

TABLE III

SUMMARY OF FIELD INVESTIGATION

Borings

| Number | Coordinates North | Coordinates East | By | Overburden Depth, Ft. | Unified Soil Classification of Overburden | Rock Type | Comments |
|---|---|---|---|---|---|---|---|
| 3 | 26328 | 23802 | WCC | 4 | GW Medium Dense | Limestone | |
| 4 | 26174 | 23944 | WCC | 30.5 | GP Colluvium | " | |
| 5 | 26019 | 24087 | WCC | 36 | GM-GW Top 9 ft., SM-SW 14 ft., GM-GW 13 ft. | " | |
| 7 | 25718 | 24365 | WCC | 1 | Colluvium | " | |
| 9 | 26470 | 23956 | WCC | 2 | GC Colluvium and weathered bedrock | " | |
| 10 | 26300 | 24140 | WCC | 36 | Colluvium | " | |
| 11 | 26160 | 24270 | WCC | 23 | SM-ML to GP Colluvium | " | |
| 12 | 26010 | 24410 | WCC | 19 | SM to GP Colluvium | Shale | Bottom of Boring 59 ft. |
| 13 | 25860 | 24530 | WCC | 0 | Limestone | Limestone | |
| 14 | 26430 | 24300 | WCC | 27 | ML Colluvium top 9 ft., 10 ft. SW-GW, 3 ft. CL, 5 ft, SM | Shale | Bottom of Boring 197 ft. |
| 15 | 26270 | 24450 | WCC | 30 | SM-ML Colluvium 2 ft., 9 ft. GP Alluvium, 19 ft, SM | Shale | Bottom of Boring 71 ft. |
| 16 | 26199 | 23662 | WCC | 0 | Limestone | Limestone | |
| 20 | 25630 | 24200 | WCC | 4 | GM Top 2 ft., GC 2 ft. | " | |
| 21 | 25940 | 23650 | WCC | 1 | GP Colluvium | " | |
| 22 | 25790 | 23790 | WCC | 49 | GC Top 26 ft., CL 23 ft. | " | |
| 23 | 25670 | 23920 | WCC | 58 | CL 27 ft., GL-GC 8 ft., SC 6 ft, GP 2 ft, GL-GC 10 ft, GP 5 ft. | " | |
| 24 | 25534 | 24018 | WCC | 17 | GC 4 ft., CL 13 ft. | " | |
| 25 * | 25780 | 23530 | WCC | 15 | GM-GW 3 ft., SW 5 ft., GM-GW 7 ft. | " | Bottom of Boring 215 Ft. |
| 26 | 25660 | 23630 | WCC | 102 | CL Colluvium 34 ft., GC Colluvium 68 ft. | " | SP 1 Ft. Lense at 73 Ft. Depth |
| 27 | 25560 | 23750 | WCC | 66 | CH 5 ft., CL 19 ft., GP 27 ft., CL 5 ft., GC 10 ft. | " | |
| 28 | Not Surveyed | | WCC | 27 | SM 14 ft., GW-GM 7 ft., GC 6 ft. | Shale | Located 15 Ft. East Boring #15 |

TABLE III

SUMMARY OF FIELD INVESTIGATION

| Number | Coordinates North | East | By | Overburden Depth, Ft. | Unified Soil Classification of Overburden | Rock Type | Comments |
|---|---|---|---|---|---|---|---|
| 1 | 25910 | 23960 | D&M | | | | |
| 2 | 26110 | 23690 | D&M | | | | |
| 3 | 25670 | 24220 | D&M | | | | |
| 4 * | 25780 | 24110 | D&M | 20 | GP Colluvium | Limestone | Bottom of Boring 100 ft. |
| 5 * | 26030 | 23810 | D&M | 20 | GP Colluvium | " | " " |
| 6 * | 26210 | 24210 | D&M | 25 | GP Colluvium, Shale 30 ft., Limestone 25 ft. | " | Limestone Bedrock |
| 7 * | 26020 | 24880 | D&M | 0 | Slight Ground Water Inflow 55 to 60 feet. In Depth | Shale | Bottom of Boring 80 ft. |
| 8 | 26720 | 25200 | D&M | 10 | Colluvium, Limestone 20 ft., Shale 50 ft., Boring 80 ft.depth | | Ground Water 37.5 ft. depth, 9-21-81 |
| 9 * | 26510 | 24590 | D&M | 20 | Colluvium, Limestone 54 ft., Shale to bottom boring 80 ft. depth | | Ground Water not encountered |
| 10 * | 26850 | 24280 | D&M | 15 | Colluvium, Limestone 40 ft., Shale to bottom boring 80 ft. depth | | Ground Water 47 ft. depth, 9-21-81 |
| 11A&B | 26560 | 24290 | D&M | 15 | Alluvium, No ground water 9-11-81 | | 2 piezometers placed |
| 12A&B | 26350 | 24830 | D&M | 15 | Colluvium, No ground water 9-10-81 | | " " |
| 13A&B | 26200 | 24210 | D&M | 15 | Colluvium, No ground water 9-10-81 | | " " |

* Denotes boring where packer test was conducted.

TABLE III

SUMMARY OF FIELD INVESTIGATION

Test Pits

| Number | Coordinates North | Coordinates East | By | Overburden Depth, Ft. | Unified Soil Classification of Overburden | Rock Type | Comments |
|---|---|---|---|---|---|---|---|
| 1 | 26492 | 24289 | D&M | | GM to Bottom of Pit at 11 ft. Depth | | Gradation & Atterberg Tests |
| 2 | 26272 | 24245 | D&M | 10.5 | GM., Bottom of Pit at 11 ft. Depth | Limestone | |
| 3 | 27560 | 25021 | D&M | | GM; Bottom of Pit at 17 ft. Depth | | |
| 4 | 27350 | 25106 | D&M | 10.5 | GM-ML 5.5 ft., GM 5 ft., Pit Bottom at 11 Ft. Depth | Limestone | |
| 5 | 27066 | 25207 | D&M | | GM to Pit Bottom at 12 ft., Depth | | Geochemical & Gradation & Atterberg |
| 6 | 26698 | 25126 | D&M | 7.5 | ML-GM; Pit Bottom at 8 ft. Depth | Shale | Gradation Tests |
| 7 | 26543 | 25037 | D&M | 5.5 | ML 2 ft., GM 3.5 ft. | | Geochemical Tests |
| 8 | 26183 | 24849 | D&M | 9.5 | SM-ML 3 ft., GC 6.5 Ft., Pit Bottom at 10 ft. Depth | Shale | Gradation Tests |
| 9 | 26187 | 24578 | D&M | | SM-ML 1.5 Ft., GM 15.5 Ft., Pit Bottom at 17 ft., Depth | | Geochemical & Gradation Tests |
| 10 | 26487 | 24744 | D&M | | GM: Pit Bottom at 11 ft., Depth | | |
| 11 | 26185 | 25025 | D&M | 8.5 | CL 2.5 Ft., GC 6 Ft., Pit Bottom at 9.5 Ft. | Shale | Atterberg Tests |
| 12 | 25973 | 25164 | D&M | | ML-SM 4.5 Ft., CL 9 Ft., Pit Bottom at 13.5 Ft. Depth | | Geochemical & Gradation Tests |
| 13 | 26347 | 25315 | D&M | | SM-ML 2 Ft., GM 10 Ft., Pit Bottom at 12 Ft., Depth | | |
| 14 | 26610 | 24170 | D&M | | GC; Pit Bottom at 14 Ft. Depth | | Gradation & Atterberg & Specific Grav. |
| 15 | 26753 | 24158 | D&M | | GC; Pit Bottom at 10 Ft. Depth | | Gradation |
| 16 | 26935 | 24161 | D&M | 10 | GC; Pit Bottom at 12 Ft. Depth | Shale | |
| 17 | 27065 | 24258 | D&M | 3 | GC: Pit Bottom at 4 Ft. Depth | Shale | |
| 18 | 26815 | 24331 | D&M | | GC: Pit Bottom at 8.5 Ft. Depth | | |
| 19 | 26566 | 24650 | D&M | | SC-CL: Pit Bottom at 8 Ft. Depth | | |
| 20 | 26605 | 24493 | D&M | | GC: Pit Bottom at 9 ft. Depth | | |
| 21 | 26708 | 24416 | D&M | | CL-GC; Pit Bottom at 9 ft. Depth | | |
| 22 | 26370 | 24222 | D&M | | GM-GP: Pit Bottom at 12 Ft. Depth | | Gradation |
| 23 | 26231 | 24172 | D&M | | GM: Pit Bottom at 9.5 Ft. Depth | | |
| 24 | 26106 | 24165 | D&M | | GM: Pit Bottom at 8 Ft. Depth | | Gradation Tests |
| 25 | 26025 | 24129 | D&M | 6 | GM 3 Ft., GP-GM 3 Ft., Limestone at 6 Ft. Depth | Limestone | Gradation Tests |
| 26 | Not Surveyed | | D&M | | GM: Pit Bottom at 8 Ft. Depth | | |

TABLE III

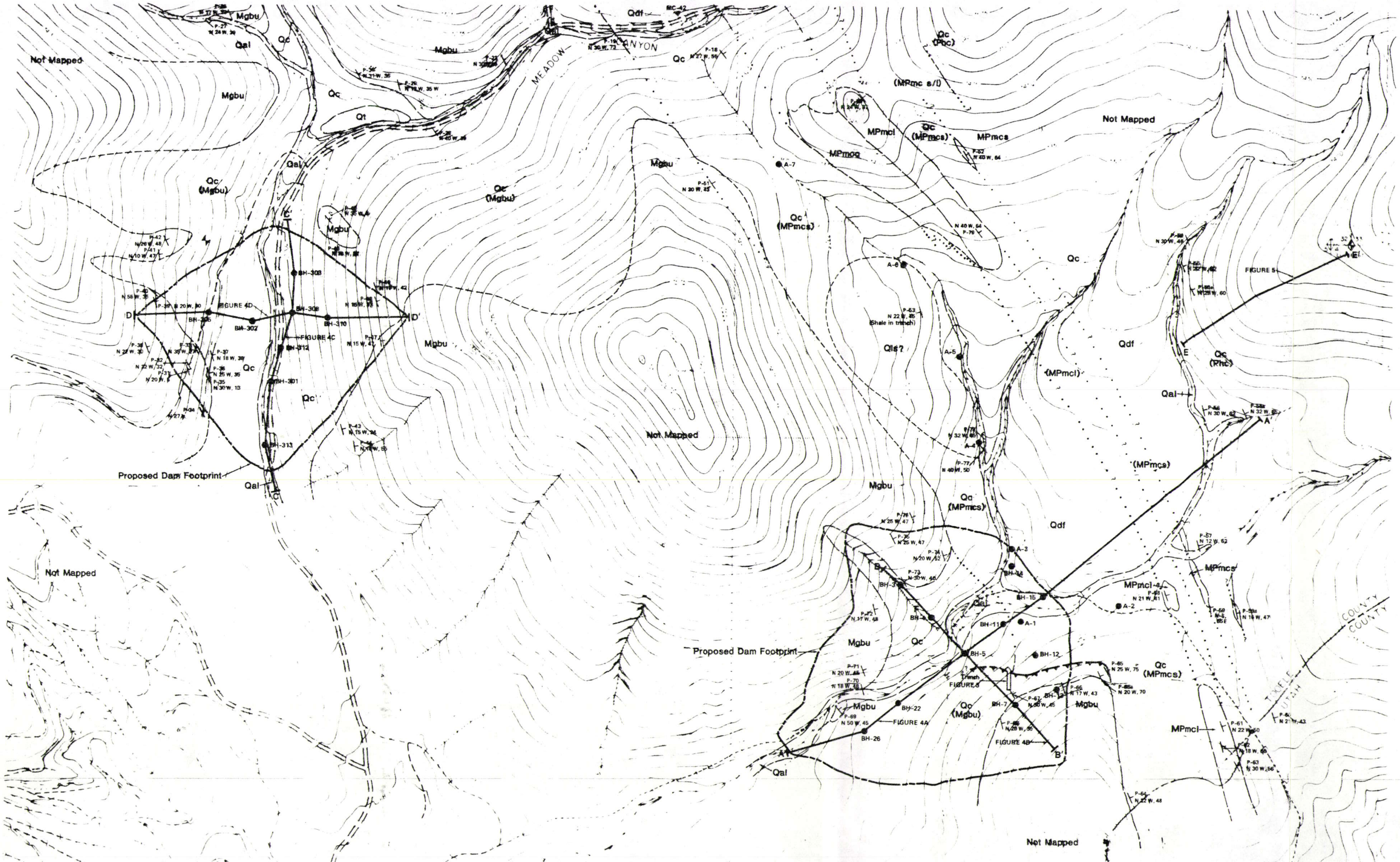
SUMMARY OF FIELD INVESTIGATION

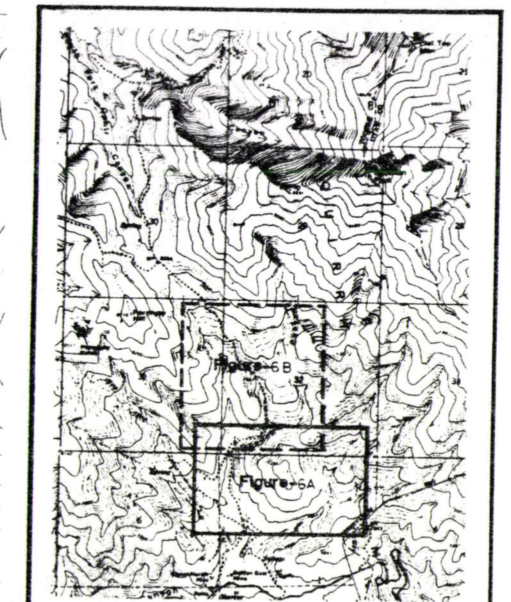
Tests Pits

| Number | Coordinates North | East | By | Overburden Depth, Ft. | Unified Soil Classification of Overburden | Rock Type | Comments |
|---|---|---|---|---|---|---|---|
| D-1 | 26163 | 24409 | WCC | | At 5 ft. Depth | | 89.5 PCF Field Dry Density |
| D-2 | 25865 | 24146 | WCC | | At 4 Ft. Depth | | 77.6 PCF " " |
| D-3 | 25891 | 24077 | WCC | | At 1 Ft. Depth | | 81.7 PCF " " |
| D-4 | 25611 | 23647 | WCC | | AT 20 Ft. Depth Test No. 4 | | 96.1 PCF " " |
| | | | | | At 15 Ft. Depth Test No. 5 | | 90.3 PCF " " |
| | | | | | At 10 Ft. Depth Test No. 6 | | 90.7 PCF " " |
| D-5 | 25508 | 24023 | WCC | | At 5 Ft. Depth Test No. 8 | | 75.4 PCF " " |
| D-6 | 26312 | 24137 | WCC | | At 10 Ft. Depth Test No. 7 | | 111.3 PCF " " |
| D-7 | 26174 | 23927 | WCC | | At 20 Ft. Depth Test No. 9 | | 93.3 PCF " " |
| | | | | | At 10 Ft. Depth Test No. 10 | | 99.1 PCF " " |
| | | | | | At 15 Ft. Depth Test No. 11 | | 87.9 PCF " " |
| D-8 | 26008 | 23780 | WCC | | At 5 Ft. Depth Test No. 12 | | 86.8 PCF " " |
| D-9 | 25871 | 23690 | WCC | | At 1 Ft. Depth Test No. 13 | | 95.1 PCF ' ' |

AUGER DRILLED BORINGS

| Number | Coordinates North | East | By | Overburden Depth, Ft. | Unified Soil Classification of Overburden | Rock Type | Comments |
|---|---|---|---|---|---|---|---|
| A-1 | 26189 | 24379 | WCC | | CL 6 Ft., Pit Bottom at 6 Ft. Depth | | |
| A-2 | 26287 | 25030 | WCC | | GM-OL 1 ft., ML 4 Ft., CL 8 Ft. | | |
| A-3 | 26476 | 24299 | WCC | | GM-OL 3 ft., ML 8 Ft. | | |
| A-4 | 26942 | 24118 | WCC | | Colluvium 2 Ft., CL 4 Ft. | Shale | |
| A-5 | 27436 | 23996 | WCC | | Colluvium 3.5 Ft., CL 7.5 Ft. | Shale | |
| A-6 | 27843 | 23728 | WCC | | Colluvium 4 ft., CL 17 Ft., Bedrock at 25 Ft. Depth | Shale | |
| A-7 | 28096 | 23316 | WCC | | CL 13 Ft. | | |




SITE LOCATION

## EXPLANATION

### GEOLOGIC UNITS

QUATERNARY

- Qal ALLUVIUM
- Qc COLLUVIUM; UNDERLYING BEDROCK IN PARENTHESES, e.g. (Mgbu)
- Qdf DEBRIS FLOW; UNDERLYING BEDROCK IN PARENTHESES, e.g. (MPmcs)
- Qls LANDSLIDE
- Qt TERRACE DEPOSIT

UNCONFORMITY

PENNSYLVANIAN

- Phc OQUIRRH FORMATION, HALL CANYON MEMBER

MISSISSIPPIAN PENNSYLVANIAN

- MPmc MANNING CANYON SHALE
  - s SHALE UNIT
  - l LIMESTONE UNIT
  - q QUARTZITE UNIT
  - s/l INTERCALATED SHALE AND LIMESTONE

MISSISSIPPIAN

- Mgbu GREAT BLUE LIMESTONE, UPPER MEMBER

### SYMBOLS

LITHOLOGIC CONTACTS:
- APPROXIMATE
- INFERRED
- CONCEALED

THRUST FAULT, BARBS ON UPPER PLATE

A—A' GEOLOGIC CROSS-SECTION

P-12 N 25 W, 42 STATION NUMBER STRIKE AND DIP OF BEDS

A-6 ● EXPLORATORY AUGER DRILL BORING

BH-301 ● EXPLORATORY ROTARY DRILL BORING

-N-

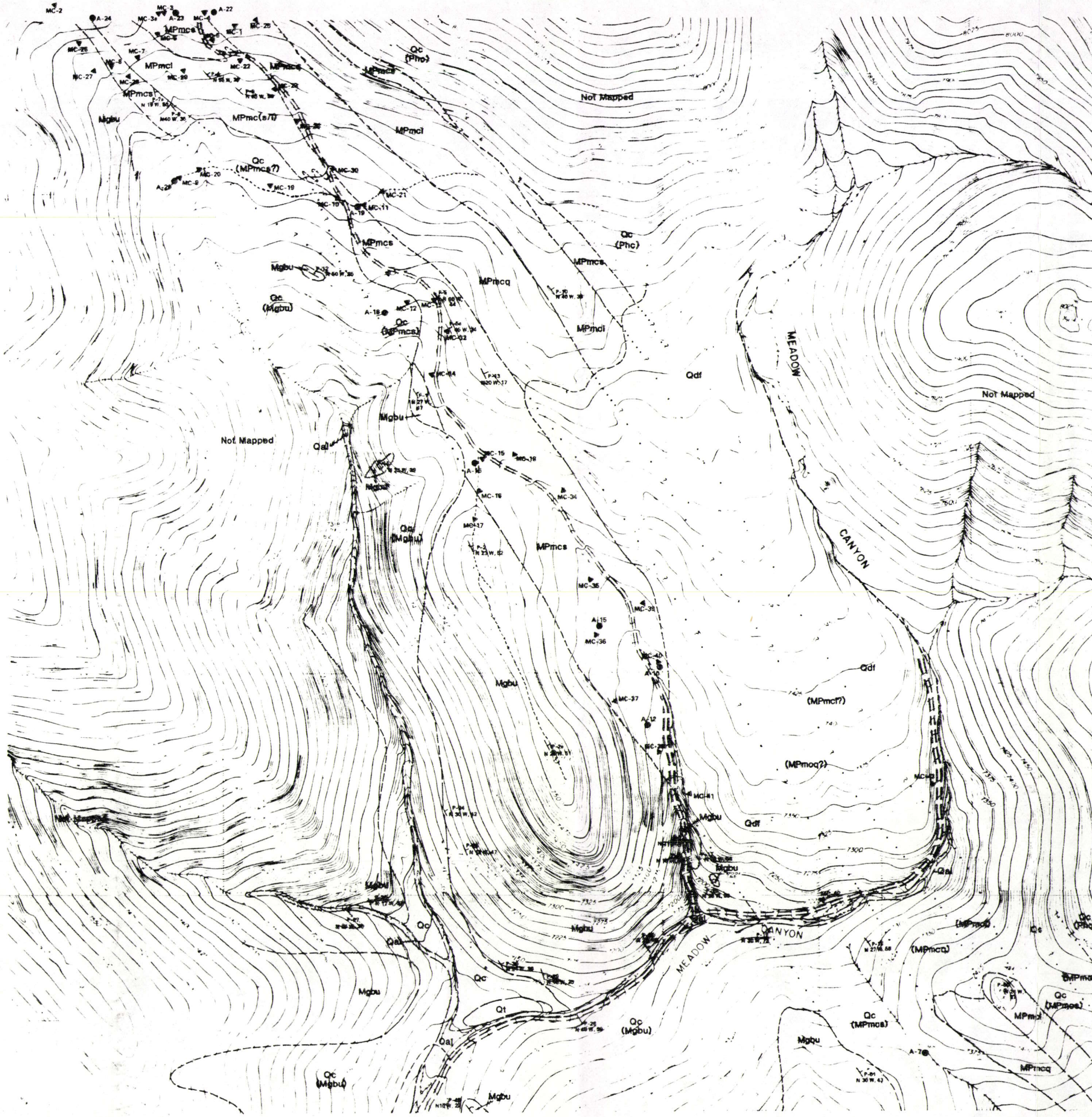
# GEOLOGIC MAP

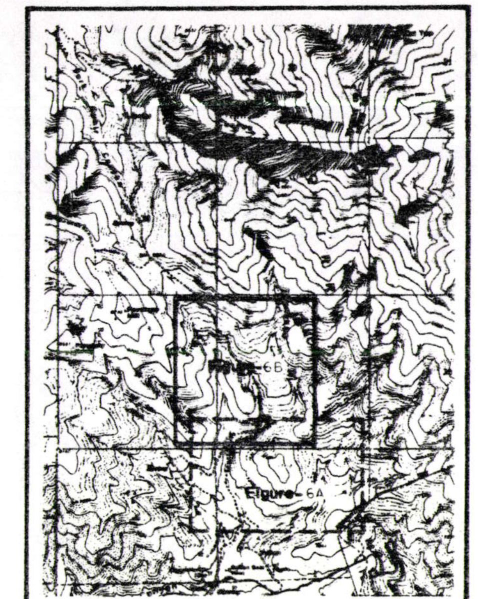
MERCUR GOLD PROJECT, POTENTIAL BORROW SOURCES
RESERVATION CANYON - MEADOW CANYON

Project No. 15141C

**Woodward-Clyde Consultants**

FIGURE-6A




SITE LOCATION

## EXPLANATION

### GEOLOGIC UNITS

QUATERNARY

- Qal — ALLUVIUM
- Qc — COLLUVIUM, UNDERLYING BEDROCK IN PARENTHESES, e.g. (Mgbu)
- Qdf — DEBRIS FLOW, UNDERLYING BEDROCK IN PARENTHESES, e.g. (MPmcs)
- Qls — LANDSLIDE
- Qt — TERRACE DEPOSIT

UNCONFORMITY

PENNSYLVANIAN

- Phc — OQUIRRH FORMATION, HALL CANYON MEMBER

MISSISSIPPIAN PENNSYLVANIAN

- MPmc — MANNING CANYON SHALE
  - s - SHALE UNIT
  - l - LIMESTONE UNIT
  - q - QUARTZITE UNIT
  - s/l INTERCALATED SHALE AND LIMESTONE

MISSISSIPPIAN

- Mgbu — GREAT BLUE LIMESTONE, UPPER MEMBER

### SYMBOLS

LITHOLOGIC CONTACTS:

- APPROXIMATE
- INFERRED
- CONCEALED
- P-12 N 25 W, 42 — STATION NUMBER STRIKE AND DIP OF BEDS
- MC-6 — EXPLORATORY BACKHOE PIT
- A-4 — EXPLORATORY AUGER DRILL BORING

N

200 100 0 200 400 600 FEET

SCALE 1" = 200'

## GEOLOGIC MAP

MERCUR GOLD PROJECT, POTENTIAL BORROW SOURCES

MEADOW CANYON—OPHIR SADDLE

Project 15141C

Woodward-Clyde Consultants

FIGURE-6B

5.0 FILED INVESTIGATION (cont'd)

Report of Preliminary Tailings Dam Study, Dames & Moore, October 12, 1981.

Basic Geotechnical Data Report, Reservation Canyon Dam Site, Woodward-Clyde Consultants, January 15, 1982.

Preliminary Geological Report, Potential Borrow Sources, Woodward-Clyde Consultants January 4, 1982.

Preliminary Basic Geotechnical Data Report, Meadow Canyon Dam and Army Depot Site, Woodward-Clyde Consultants December 7, 1981.

In-Situ Density Testing Reservation Canyon and Meadow Canyon Dam Site Woodward-Clyde Consultants, January 27, 1982.

Filter Material Gradation Analyses, Reservation Canyon Dam Project Mercur Gold Project, Woodward Clyde Consultants, December 11, 1981.

Table 2
Field Investigative Techniques

| Test | Use |
| --- | --- |
| Seismic Refraction Lines | To determine the depth of overburden along the embankment and impoundment |
| Test Pits | To study the subsurface profile in the impoundment area, in borrow areas, and in the embankment foundation area. |
| Standard Penetration Test | To obtain disturbed soil samples of overburden material. In this site, this test was not a good density indicator. |
| Sand Cone Density Tests | To determine the in situ density of coarse overburden material. |
| Rock Coring | To obtain core samples of rock materials for visual classification and/or laboratory testing. |
| Falling Head Permeability Tests | To determine soil permeability in relatively pervious soils. |
| Packer Permeability Test | To determine the permeability of the subsurface rock under a hydraulic pressure equal to the reservoir pressure. |

## 6.0 LABORATORY INVESTIGATION

Laboratory testing of construction materials and of tailings has been conducted by Dames & Moore and by Woodward Clyde Consultants. The specifications for geotechnical laboratory testing are presented in Appendix B.

Figures 7 and 8 present the Mohr-Coulomb envelope from triaxial testing of core material under unconsolidated undrained (quick loading) conditions. Figure 9 shows the effective stress Mohr-Coulomb envelope for consolidated undrained triaxial tests of core material, and Figure 10 shows the total stress envelope.

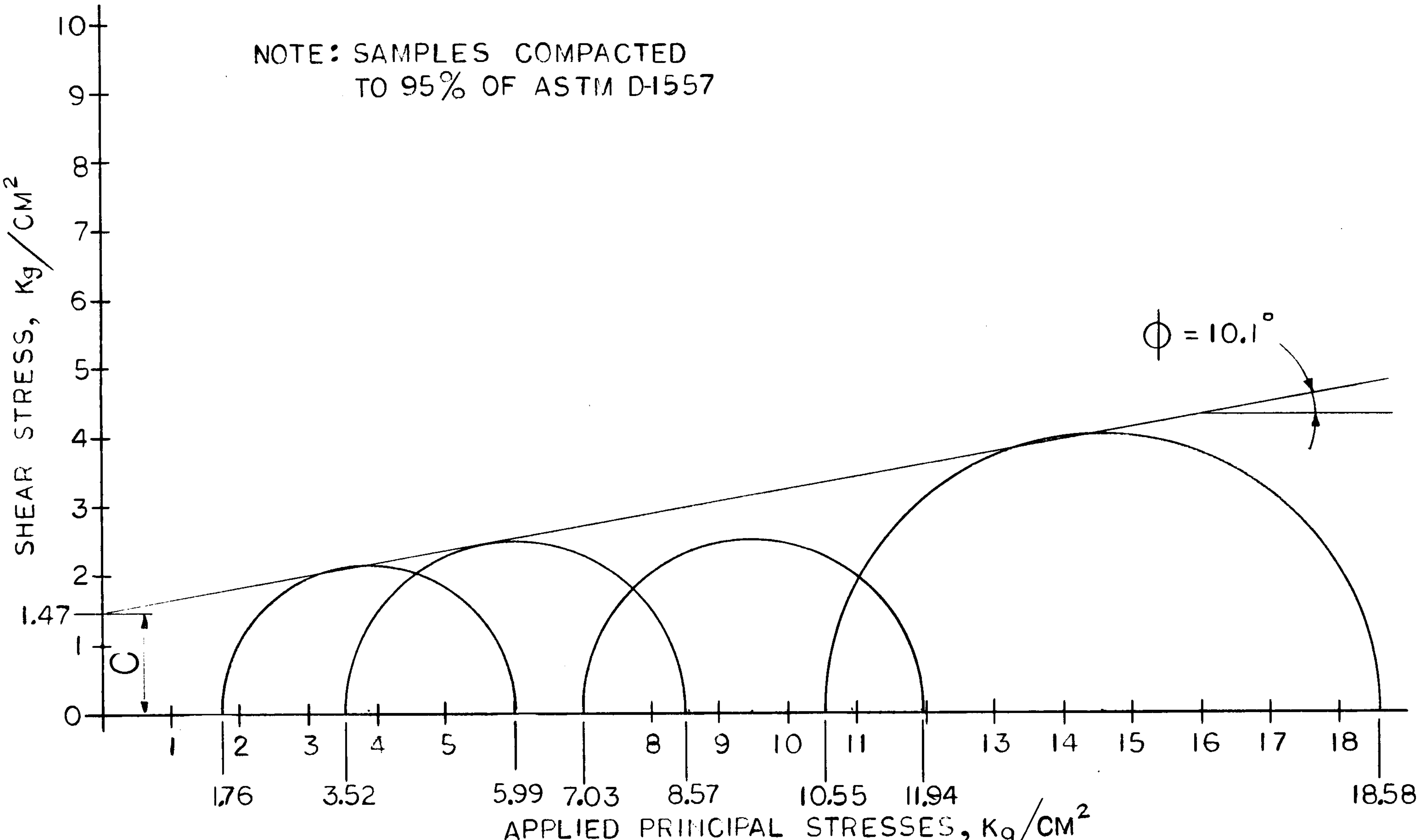



FIGURE 7
CORE MATERIAL — MOHR ENVELOPE
U.U. TRIAXIAL TESTS

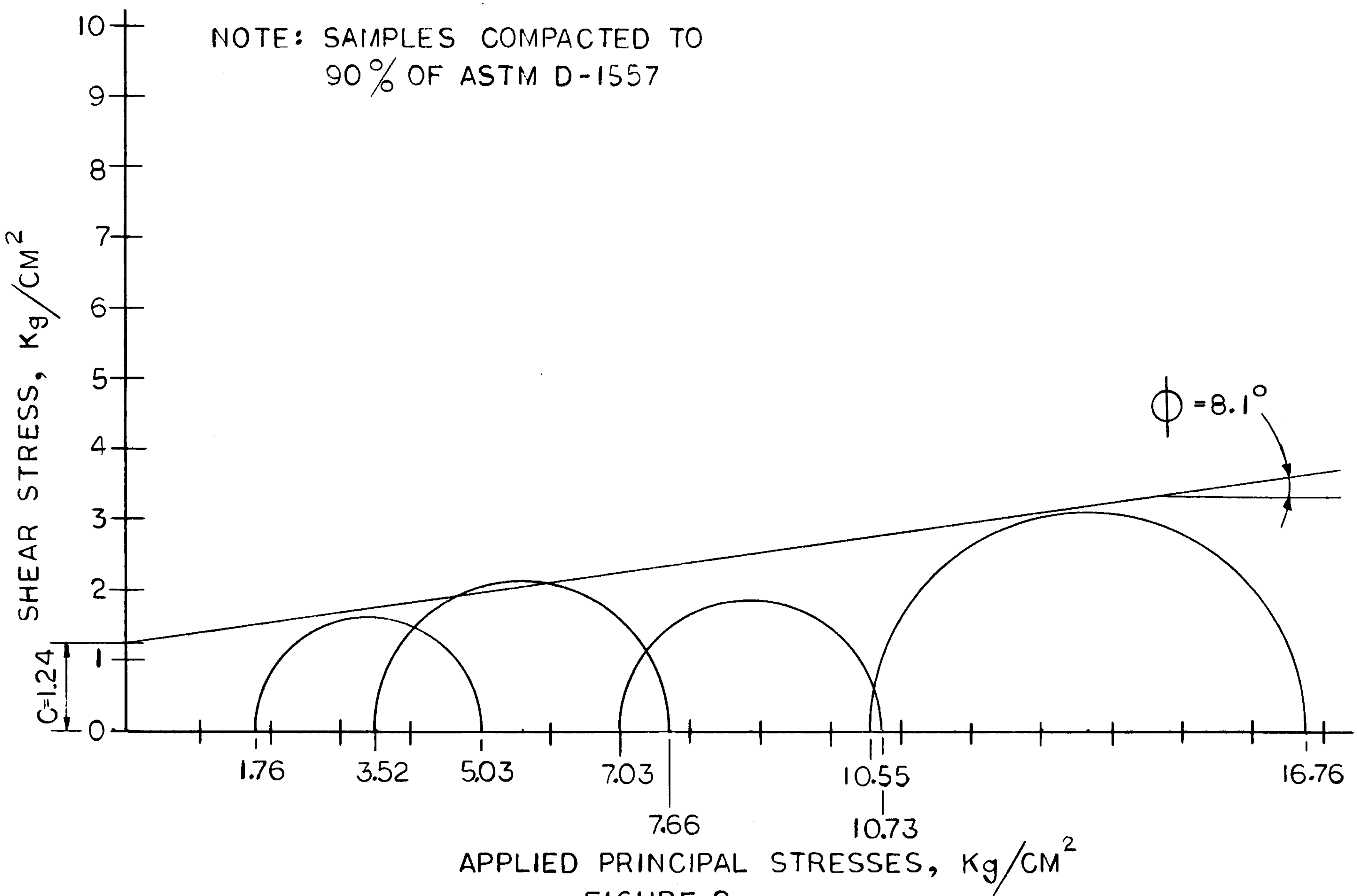



FIGURE 8
CORE MATERIAL — MOHR ENVELOPE
UU TRIAXIAL TESTS

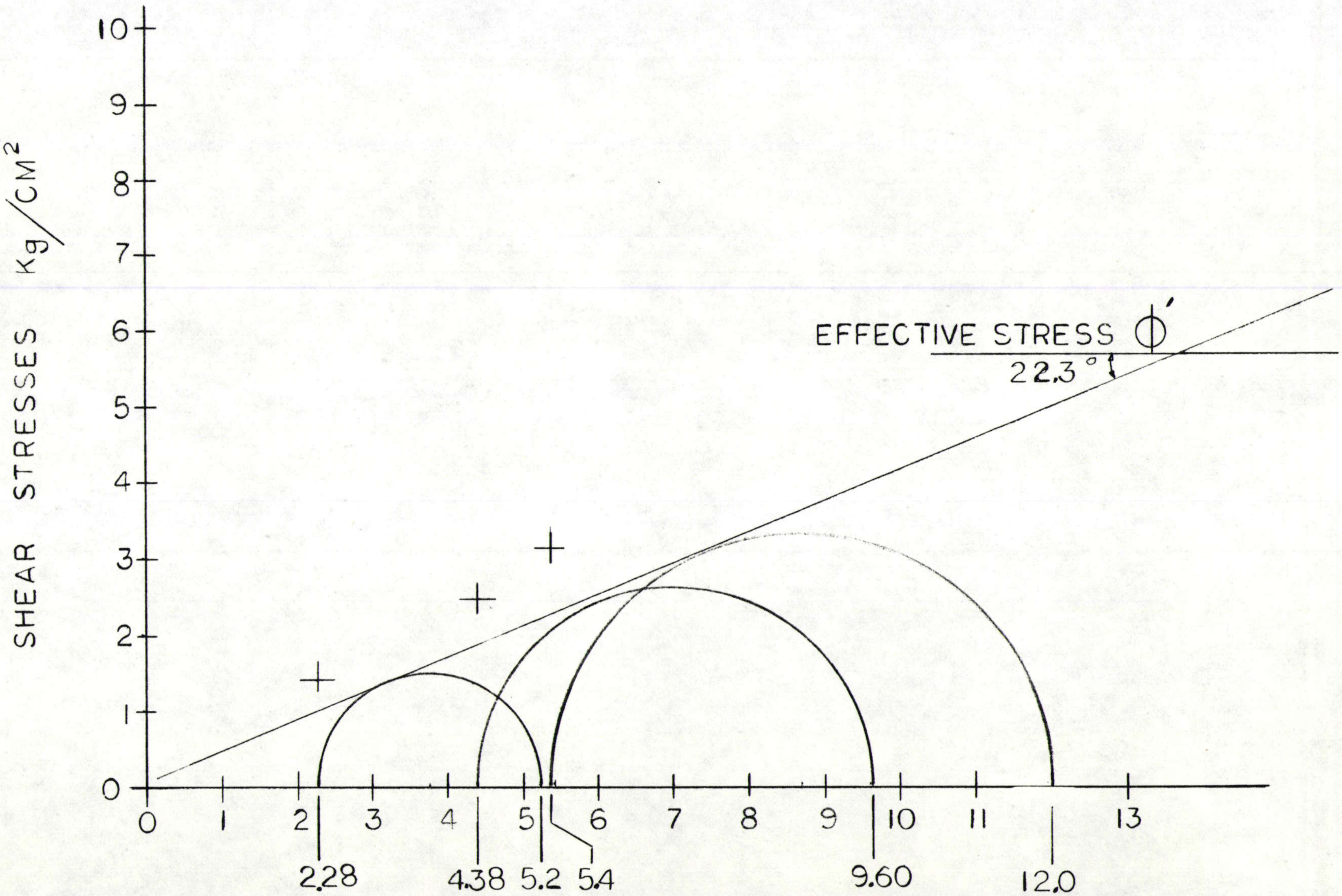



FIGURE 9

CORE MATERIAL — EFFECTIVE STRESS ENVELOPE

CIU TRIAXIAL TEST

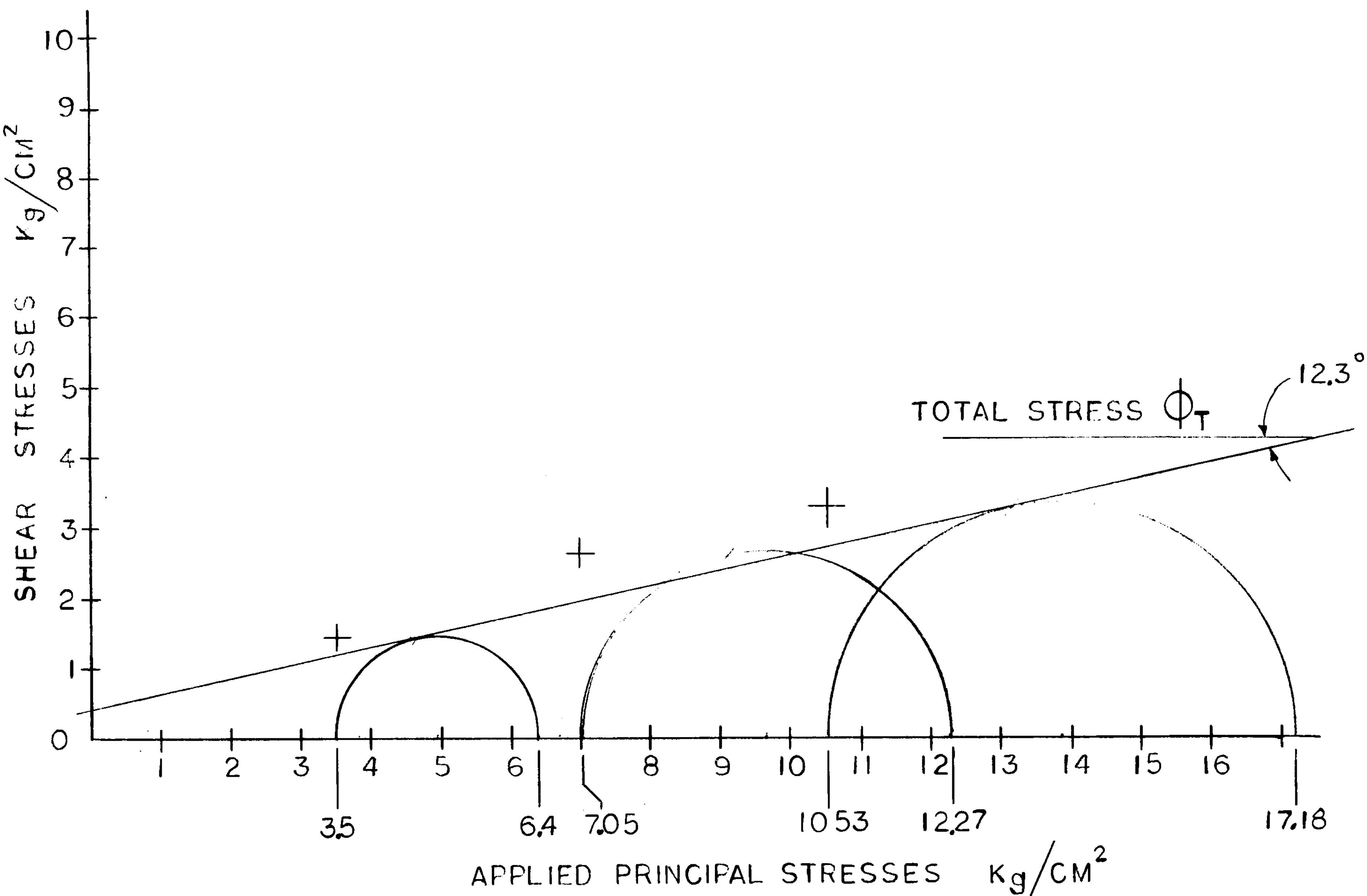



FIGURE 10
CORE MATERIAL TOTAL STRESS ENVELOPE
ICU TRIAXIAL TEST

# 7.0 EMBANKMENT ANALYSIS AND DESIGN

## 7.1 Stability Analysis

### 7.1.1 General

Stability analysis was performed using the computer program "SLOPE" maintained and operated by McDonald Douglas Automation Company. This program uses a limit equilibrium solution known as the simplified Bishop Method. The failure surfaces for this method of analysis are all circular.

### 7.1.2 Design Conditions and Applicable Safety Factors

Of the cases of analyses listed in Section 2.5.8, the controlling cases are:

(a) The slope stability of the Stage I embankment at the end of construction. This case is the critical end of construction case because the largest height of embankment will be built in the shortest construction period, and there will be no tailings stored behind the relatively steep upstream slope (supporting the slope).

(b) The long-term stability of the stage III embankment. This case is critical because the embankment height is the largest and the crest is narrower than for intermediate stages.

Idealized critical cross-sections corresponding to these cases are shown in Figures 11 and 13 for cases (a) and (b), respectively.

Figures 11 and 12 show the results of the stability analyses at the end of construction for the Stage I embankment under static and pseudo-static loadings, respectively. On the other hand, Figures 13 and 14 show results of static and pseudo static analyses, respectively for the final operating conditions.

A minimum factor of safety of 1.2 has been accepted for the end of construction static stability because the design parameters used for the core material are conservative. These parameters assume no dissipation of pore pressures. In reality, some pore pressure dissipation will occur and the real safety factor will be larger than that calculated.

The safety factor for the pseudo-static stability of the upstream slope for the end of construction case of the Stage I embankment is less than the nominal factor of safety of 1.15 required by the design criteria, but the use of a seismic coefficient of 0.1g is believed to be unnecessarily severe for the short time of exposure that corresponds to the end of construction condition.

### 7.1.3 Design Parameters

The appropriate design shear strengths used for each design condition are listed in Table 4 in general terms. Specific material properties are shown in the stability sections, Figures 11 through 14.

## 7.0 EMBANKMENT ANALYSIS AND DESIGN (cont'd)

### 7.1.4 Phreatic Surface Location

The phreatic surface was estimated considering:

a) Boundary conditions specific to each case analyzed.

b) Anisotropic ratios of permeability (horizontal to vertical) of 9 for core material and 15 for shell and filter materials.

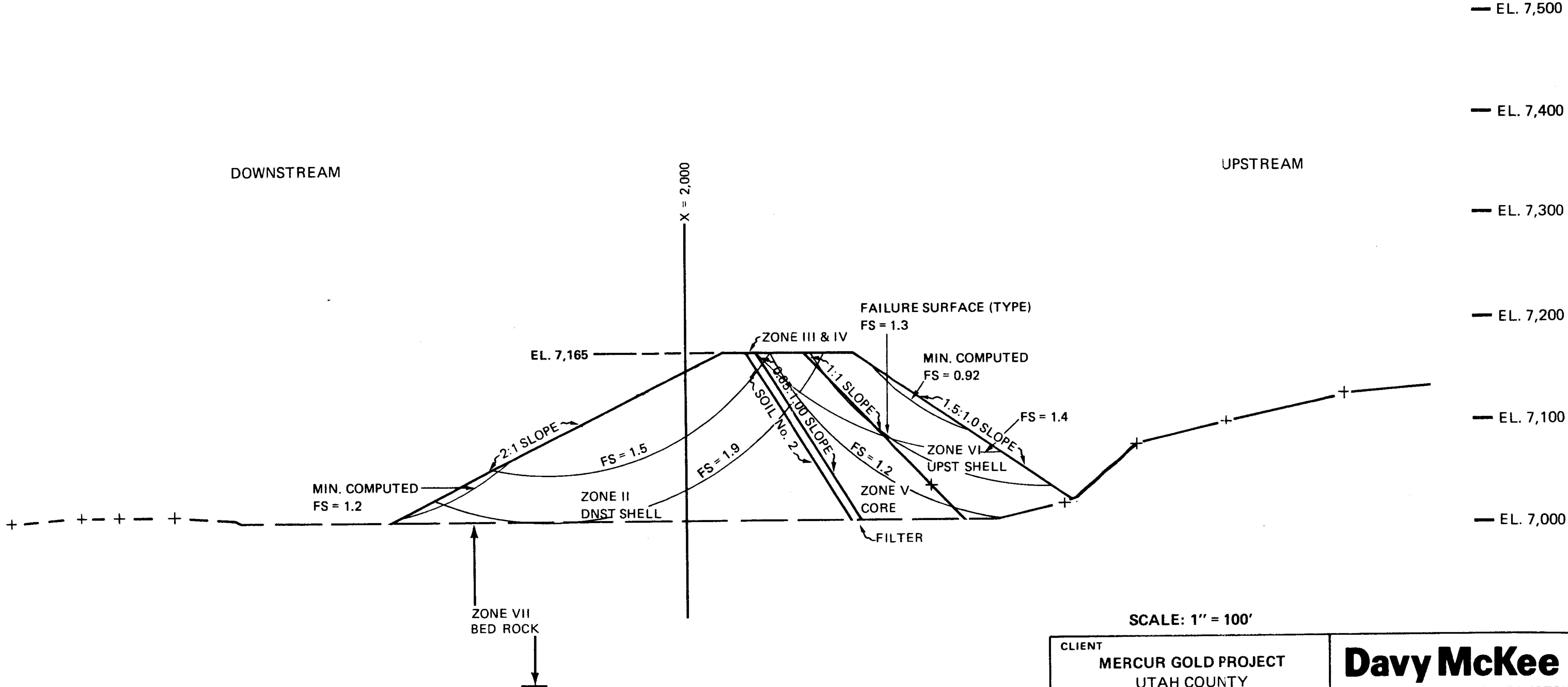
c) No beach has been assumed.

The phreatic surfaces used in the stability analysis are shown in Figures 11 through 14.

### 7.2 Embankment Design

Figure 15 shows a typical design cross-section. It shows a zoned embankment with an upstream sloping core. The upstream slope (zone VI) consists of sandy to clayey gravel with boulders and cobbles placed at a slope of 1.5 horizontal to 1 vertical. The more rocky material shall be used for this zone. The coarser material shall be placed towards the outside and the finer material adjacent to the core. The core consists of clay and broken-down shale from the impoundment area. An effort has been made to locate the core on the Manning Canyon Shale. This will produce a continuous impervious seepage barrier. However, the contact between Manning Canyon Shale and the Upper Great Blue Limestone Formation is irregular. See Figure 3. Consequently, the sections where the core does not naturally tie into

| ZONE | II | III & IV | V | VI | VIII |
|---|---|---|---|---|---|
| $\gamma_T$, UNIT WT. | 130 | 130 | 130 | 130 | 150 |
| PHI ANGLE | 30 | 35 | 10 | 30 | 35 |
| COHESION | 0 | 0 | 2,000 | 0 | 9,000 |




SCALE: 1" = 100'

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UTAH COUNTY
GETTY MINING COMPANY
Salt Lake City, Utah

**Davy McKee**
DMC ENGINEERS & CONSTRUCTORS
SAN MATEO, CALIFORNIA

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TITLE
**STAGE I TAILINGS DAM**
**END OF CONSTRUCTION CASE**
**STATIC STABILITY ANALYSIS**

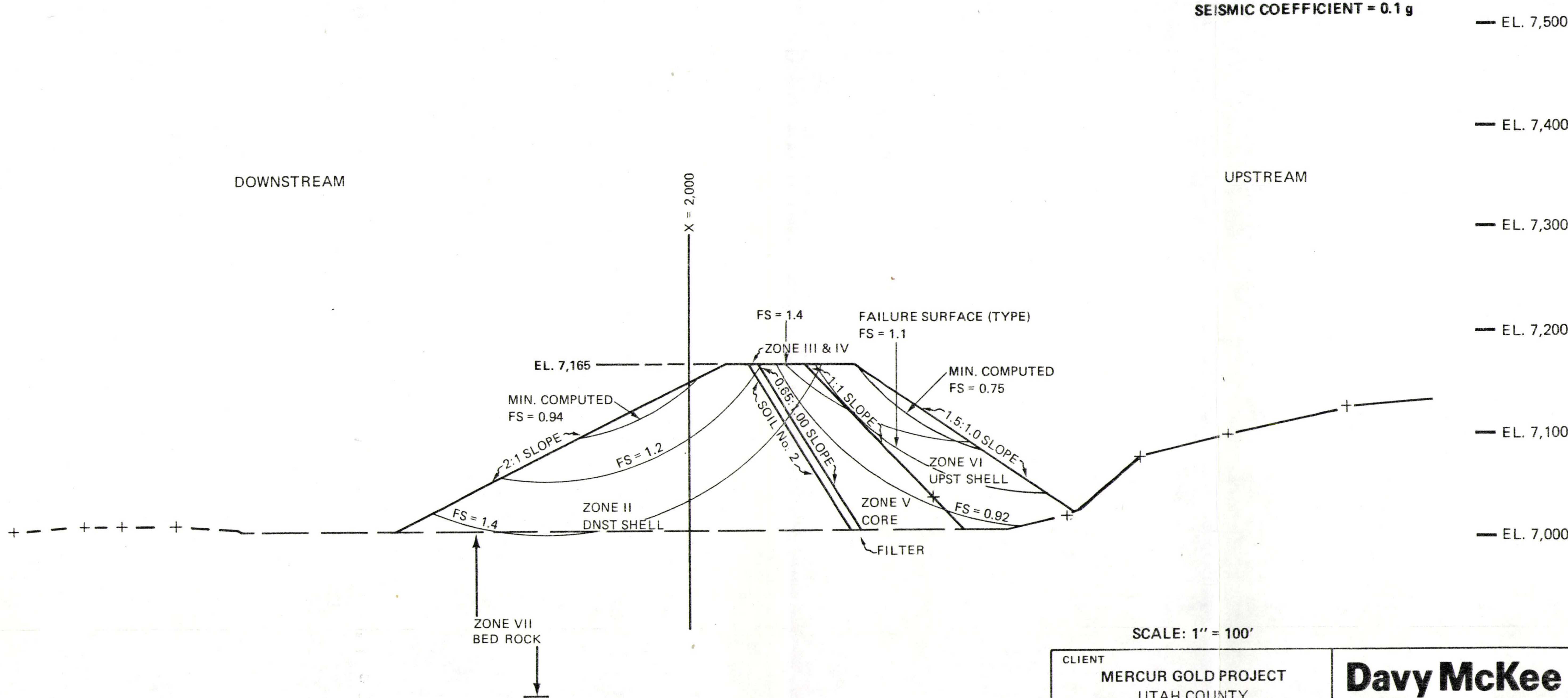
SCALE 1" = 100'
REV.

**FIGURE 11**

S ENG-28 REV. 10/79

| ZONE | II | III & IV | V | VI | VIII |
|---|---|---|---|---|---|
| $\gamma_T$, UNIT WT. | 130 | 130 | 130 | 130 | 150 |
| PHI ANGLE | 30 | 35 | 10 | 30 | 35 |
| COHESION | 0 | 0 | 2,000 | 0 | 9,000 |

**SEISMIC COEFFICIENT = 0.1 g**

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TITLE
**STAGE I TAILINGS DAM
END OF CONSTRUCTION CASE
PSEUDO STATIC STABILITY
ANALYSIS**

SCALE 1" = 100'

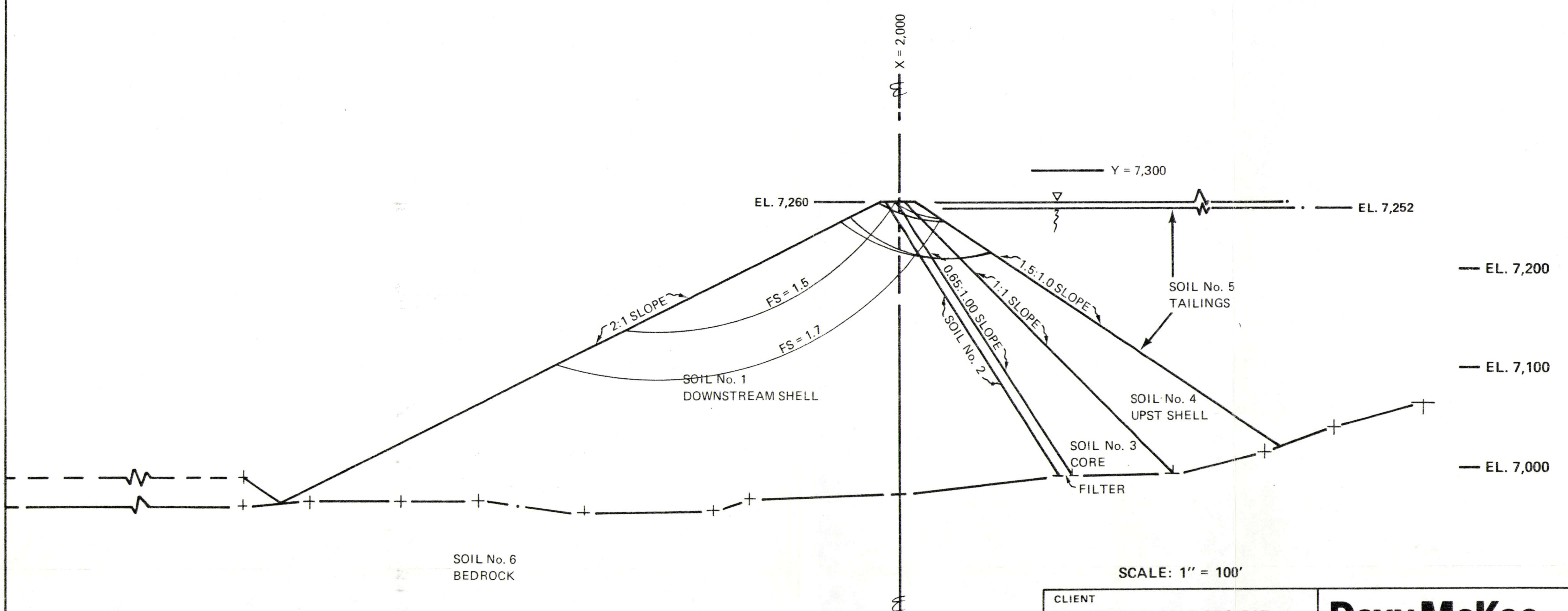
REV.

**FIGURE 12**

S ENG-28 REV 10/79

| SOIL ZONE | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| $\gamma_T$, UNIT WT., pcf | 125 | 130 | 120 | 130 | 100 | 150 | N/A |
| $c$, COHESION, psf | 0 | 0 | 0 | 0 | 0 | 9,000 | N/A |
| $\phi$, PHI ANGLE, DEG. | 35 | 35 | 35 | 35 | 30 | 30 | N/A |

**NOTE: The factors of safety for the upstream slope are very high. Results are not shown.**




SCALE: 1" = 100'

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TITLE
RESERVATION CANYON DAM
STAGE III
STATIC STABILITY ANALYSIS
END OF OPERATION

SCALE

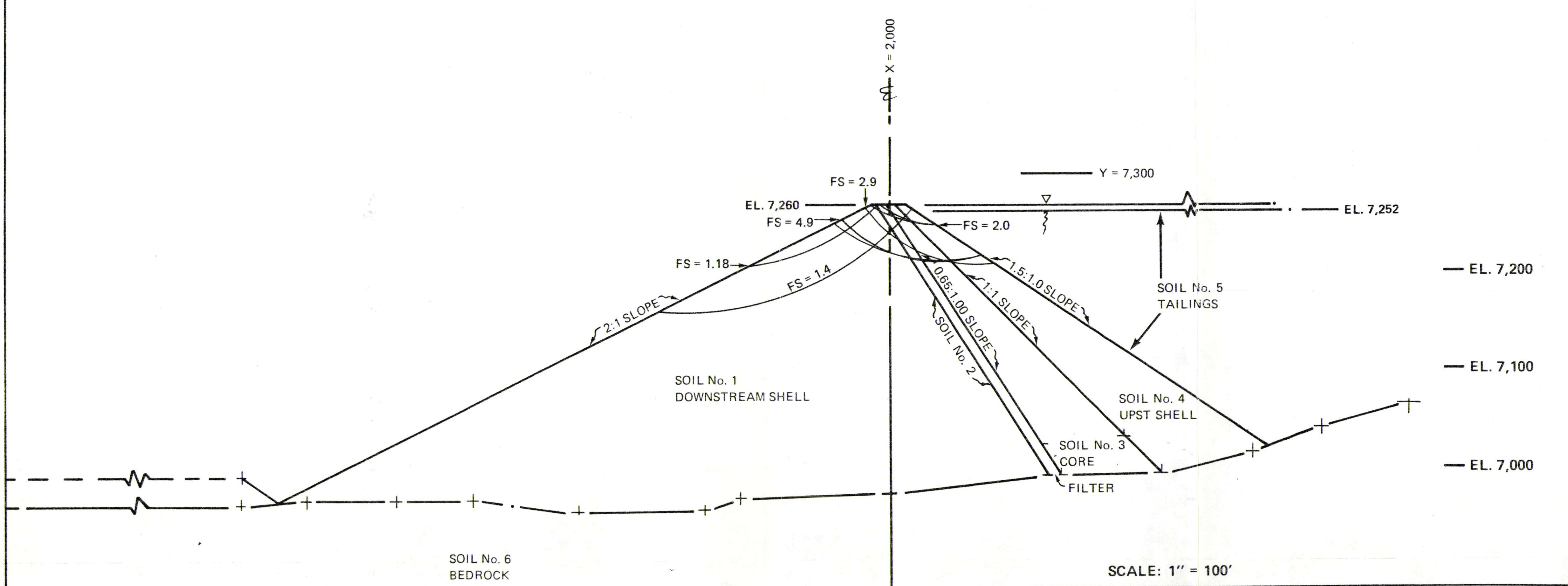
FIGURE 13

REV.

S ENG-28 REV. 10/79

| SOIL ZONE | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| $\gamma_T$, UNIT WT., pcf | 125 | 130 | 120 | 130 | 100 | 150 | N/A |
| $c$, COHESION, psf | 0 | 0 | 400 | 0 | 0 | 9,000 | N/A |
| $\phi$, PHI ANGLE, DEG. | 35 | 35 | 18 | 30 | 0 | 30 | N/A |

SEISMIC COEFFICIENT = 0.1 g

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TITLE
RESERVATION CANYON DAM
STAGE III
PSEUDO STATIC STABILITY
ANALYSIS

SCALE

FIGURE 14

REV.

S ENG-28 REV. 10/79

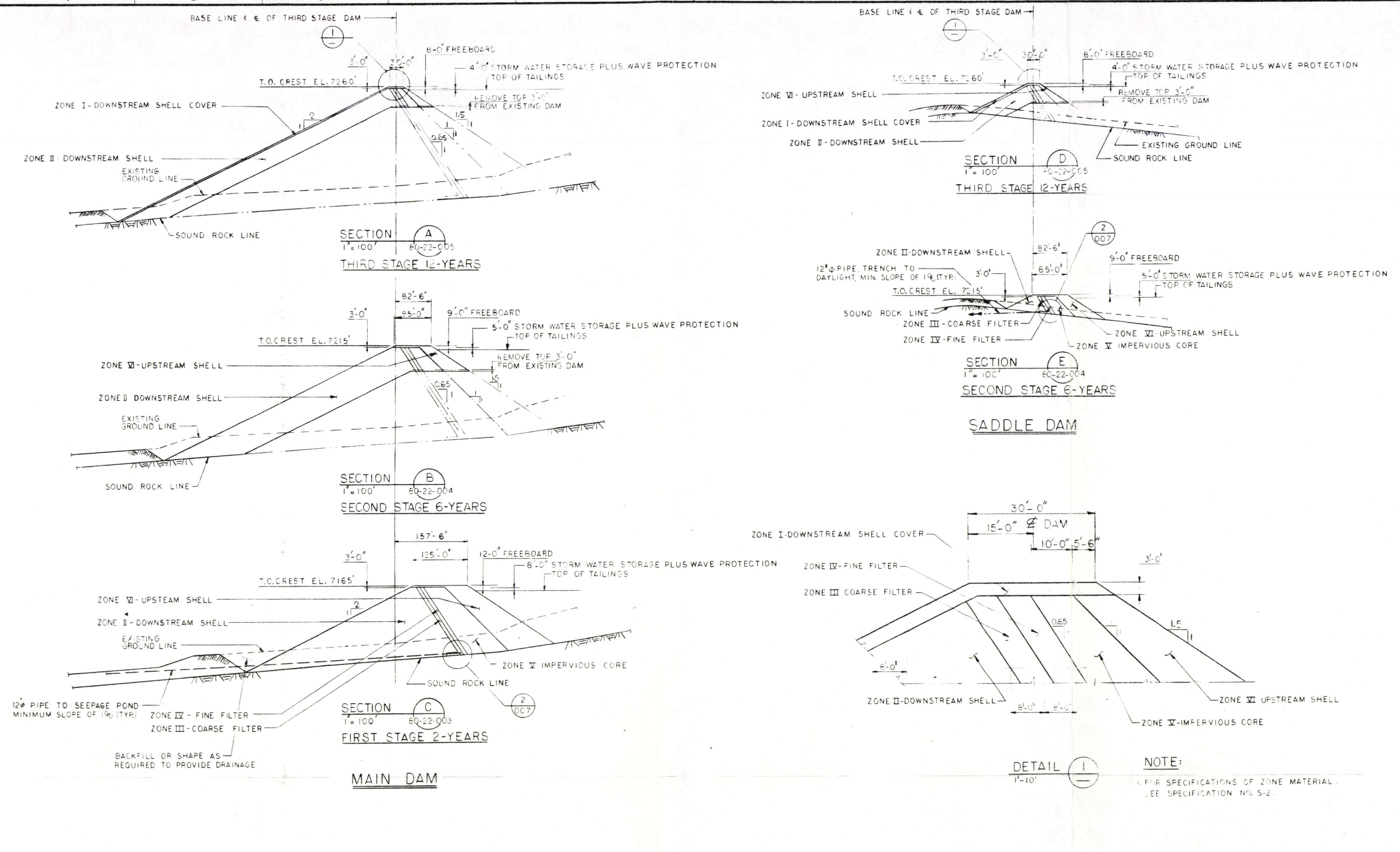


FIGURE 15

MERCUR GOLD PROJECT
TOOELE COUNTY
GETTY MINING COMPANY
Salt Lake City, Utah

Davy McKee
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San Mateo, California

RESERVATION CANYON TAILINGS DISPOSAL DAMS CROSS-SECTONS

SCALE AS NOTED
DRAWING No. SC 2365 A
80-22-006
SHEET 6 OF

DESIGNED
DRAWN H.A.D. 12/8/81
CHECKED
APPROVED 1 1.29.82

REVISIONS: ISSUED FOR APPROVAL; ISSUED FOR

DRAWING NO. 80-22-006

shale shall have a 10-foot high horizontal leg extending upstream from the sloping core contact to 20 feet over the shale foundation past the natural contact between the upper Great Blue Limestone and the Manning Canyon Shale. See Figure 15A.

Downstream from the core is a filter and a drain or coarse filter with a network of collection slotted pipes. The system is designed to direct seepage in a controlled manner to the seepage reclaim pond. The downstream slope (2 horizontal to 1 vertical) is composed of overburden material from the dam foundation excavation and the borrow areas at the future tailings impoundment area. It consists of sandy to clayey gravel with boulders and cobbles. Erosion protection for the downstream slope shall be provided for the Stage III embankment. This may consist of rip rap or other suitable material. The stability of the downstream shell is enhanced by the filters and drainage collection system. These will prevent saturation of the downstream shell and its consequential loss of effective strength.

### 7.3 Seepage Collection System and Seepage Reclaim Pond

Figure 16 shows the filter drain and pipe system designed to carry seepage to the seepage reclaim pond. From there,

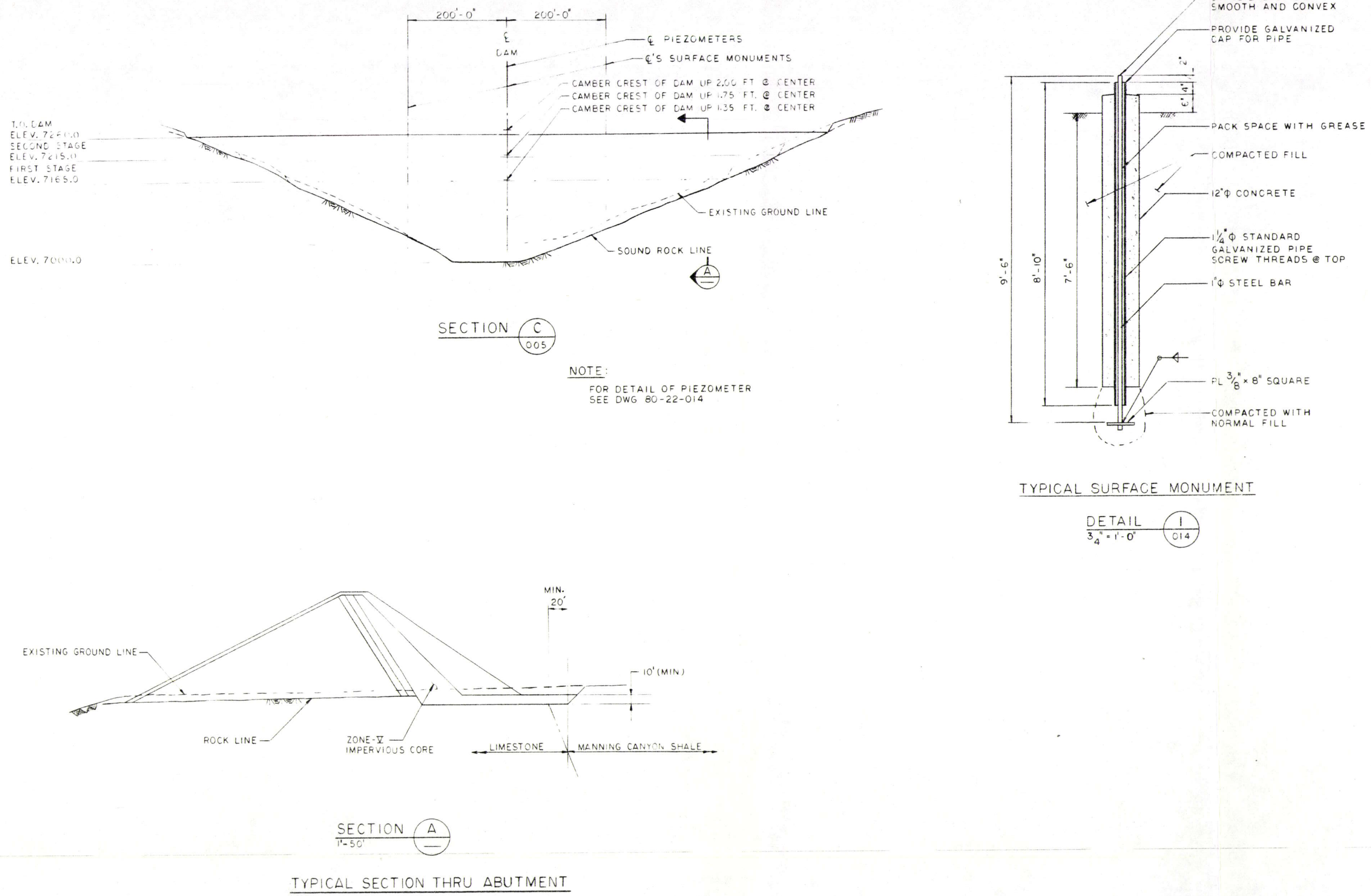


FIGURE - 15A

**MERCUR GOLD PROJECT**
**TOOELE COUNTY**
**GETTY MINING COMPANY**
**Salt Lake City, Utah**

**Davy McKee**
DMC Engineers and Constructors
San Mateo, California

TITLE: RESERVATION CANYON TAILINGS DISPOSAL DAM LONGITUDINAL SECTION

SCALE: 1"-100' (U.N.)
DRAWING No. SC2385A
80-22-007
SHEET 7 OF 17

| NO. | DESCRIPTION | BY | CH. | APPROVED | DATE |
|---|---|---|---|---|---|
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| 2 | Issued for B.D. | | | | |

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| DESIGNED | | |
| DRAWN | KG | |
| CHECKED | | |
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| APPROVED 2 | | |
| APPROVED 3 | | |

DRAWING NO. 80-22-007

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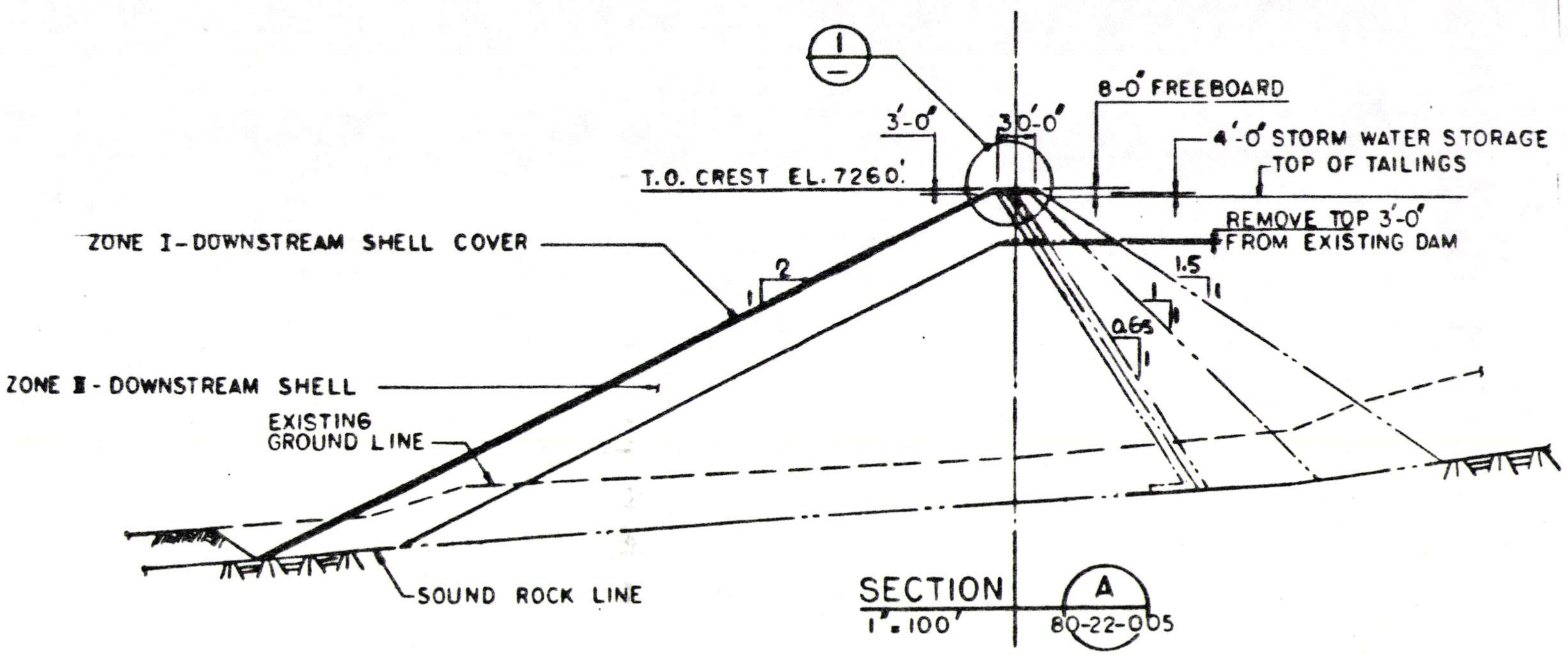
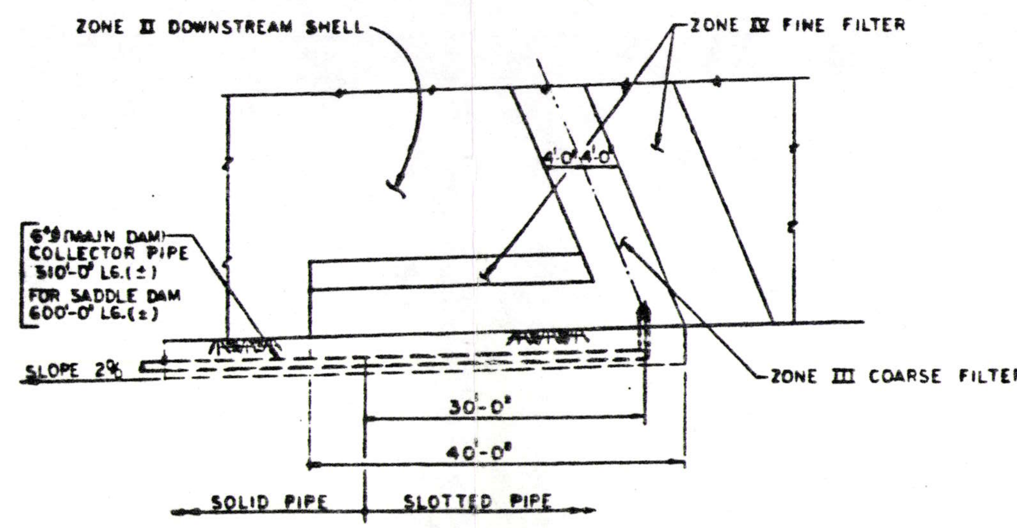
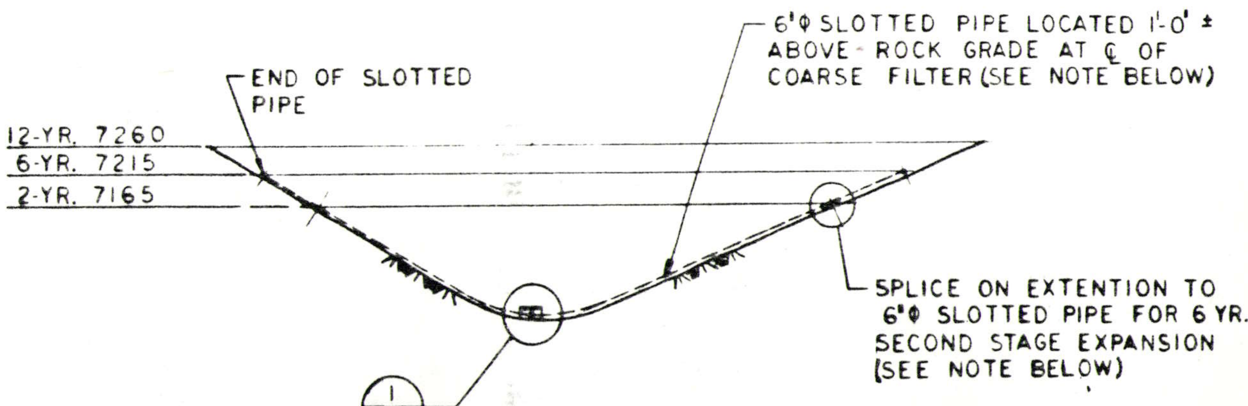



SECTION 1" = 100' A 80-22-005

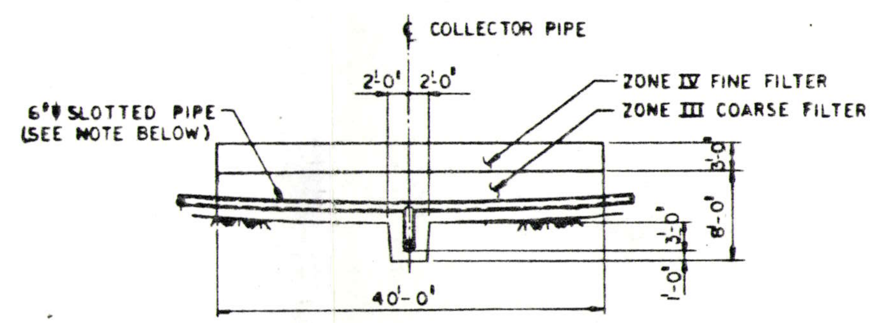
STAGE 3




DETAIL 1" = 10'-0" 2 006




SECTION 1" = 200'-0" A 003




NOTE:
FILTER PIPE SHALL BE 6"φ SCHD. 80, ASTM 1785, TYPE-1, PVC. 1120, W/ 0.64 INCH WIDE SLOTS, AS MANUFACTURED BY HYDROPHILIC INDUSTRIES, INC. PUYALLUP, WASHINGTON OR EQUAL

DETAIL 1" = 10'-0" 1

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TITLE
DETAILS OF FILTER DRAIN AND PIPE SYSTEM RESERVATION CANYON TAILINGS DAM

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DMC ENGINEERS & CONSTRUCTORS
SAN MATEO, CALIFORNIA

SCALE
DRAWING No.
FIGURE 16
REV.

S ENG-28 REV. 10/79

the seepage will be pumped back to the process or to the tailings impoundment.

The fine filter design did not adhere to the provisions of Section 2.5.5, because this design criteria is not suited for piping protection of a clay core under the worst possible case - i.e., in the event of a cracked core. Instead, the D50 of the filter was made less than or equal to 25 times the D50 of the design core grain size distribution which was developed on the basis of the minus No. 4 United States Sieve fraction of the natural core material. In addition, enough cohesionless fines were specified to preclude piping of clay flocs.

### 7.4 Foundation and Abutment Preparation

At the core and filter contact, the foundation will be excavated to competent rock. If cracks are found, these will be cleaned and filled with slush grout.

Abutment slopes will be limited to 0.5 horizontal to 1 vertical. Detail construction requirements are given in the construction specifications shown in Appendix A.

### 7.5 Deformation Analysis

The Franklin and Chang (6) modification of the Newmark (10) method of Analysis has been used to estimate embankment deformations due to strong motions. See Figure 17. Values of maximum ground acceleration at the foundation rock were determined from attenuation curves developed by: Schnabel and Seed (15) for the Wasatch Front earthquake, and by Pyke (11) for the West Mercur Fault earthquake.

The maximum crest acceleration, u max, and the natural period of the embankment, $T_o$ have been estimated using a simplified dynamic response analysis procedure originally proposed by Makdisi and Seed (1978). This method takes into account nonlinear variation of soil damping ratio, D, and Shear Modulus of Deformation, G, with shear strain, . See Figure 18. The north-south component of the Taft record for the 1952, Kern County, California, earthquake was used in response calculations.

Subsequently, the crest acceleration, $u_{max}$ was used to obtain the maximum average seismic coefficient $K_{max}$, using Figure 19.

Finally, displacements were determined for the most critical failure planes, for a range of possible values of the shear modulus parameter, $K_2$. These are shown in Figure 20 for earthquakes originating at the Wasatch Fault, and in Figures 21A and 21B for earthquakes originating at the West Mercur Fault.

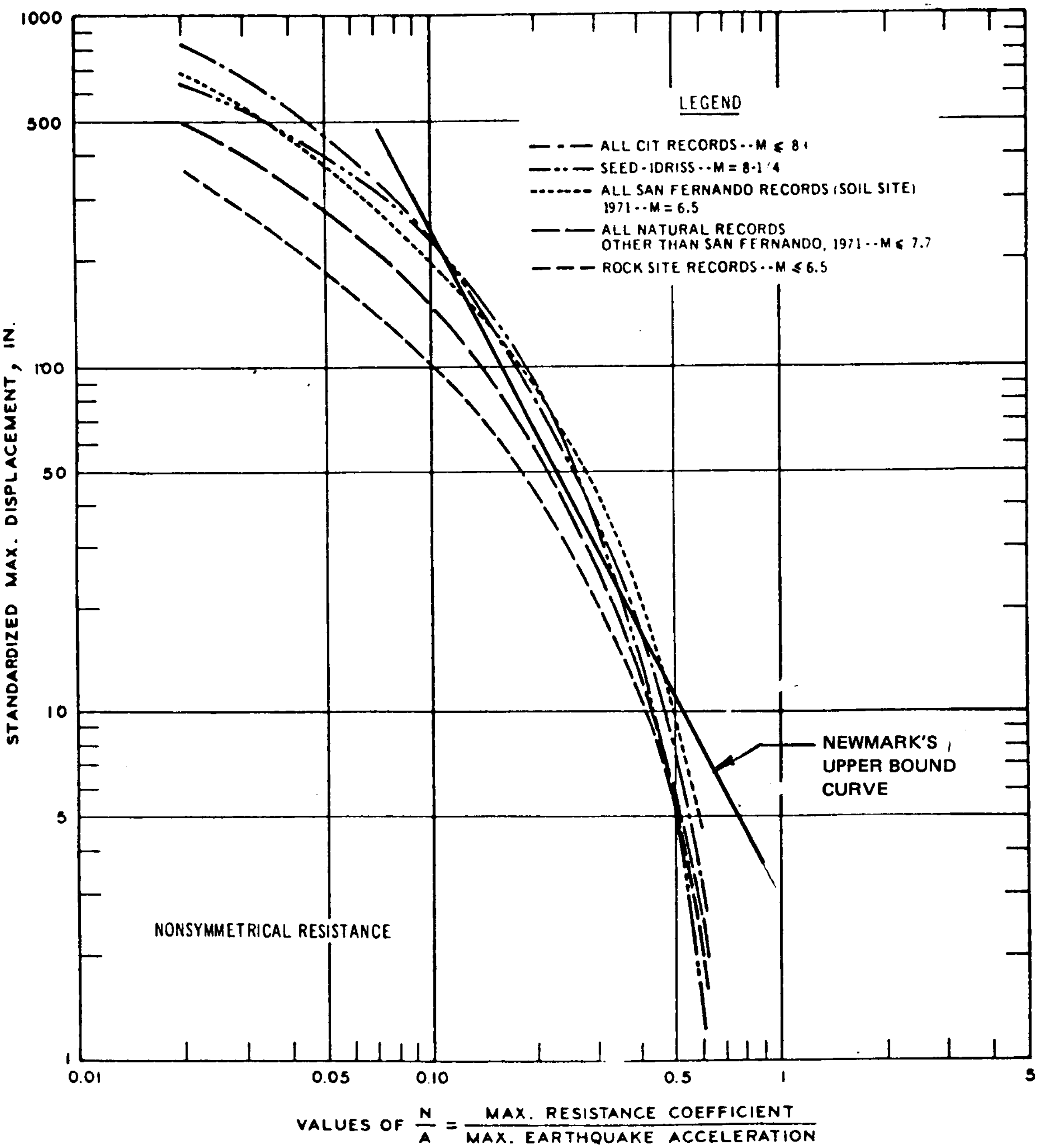



Figure 17 Upper bound envelope curves of permanent displacements for all natural and synthetic records analyzed, after Franklin and Chang (1977).

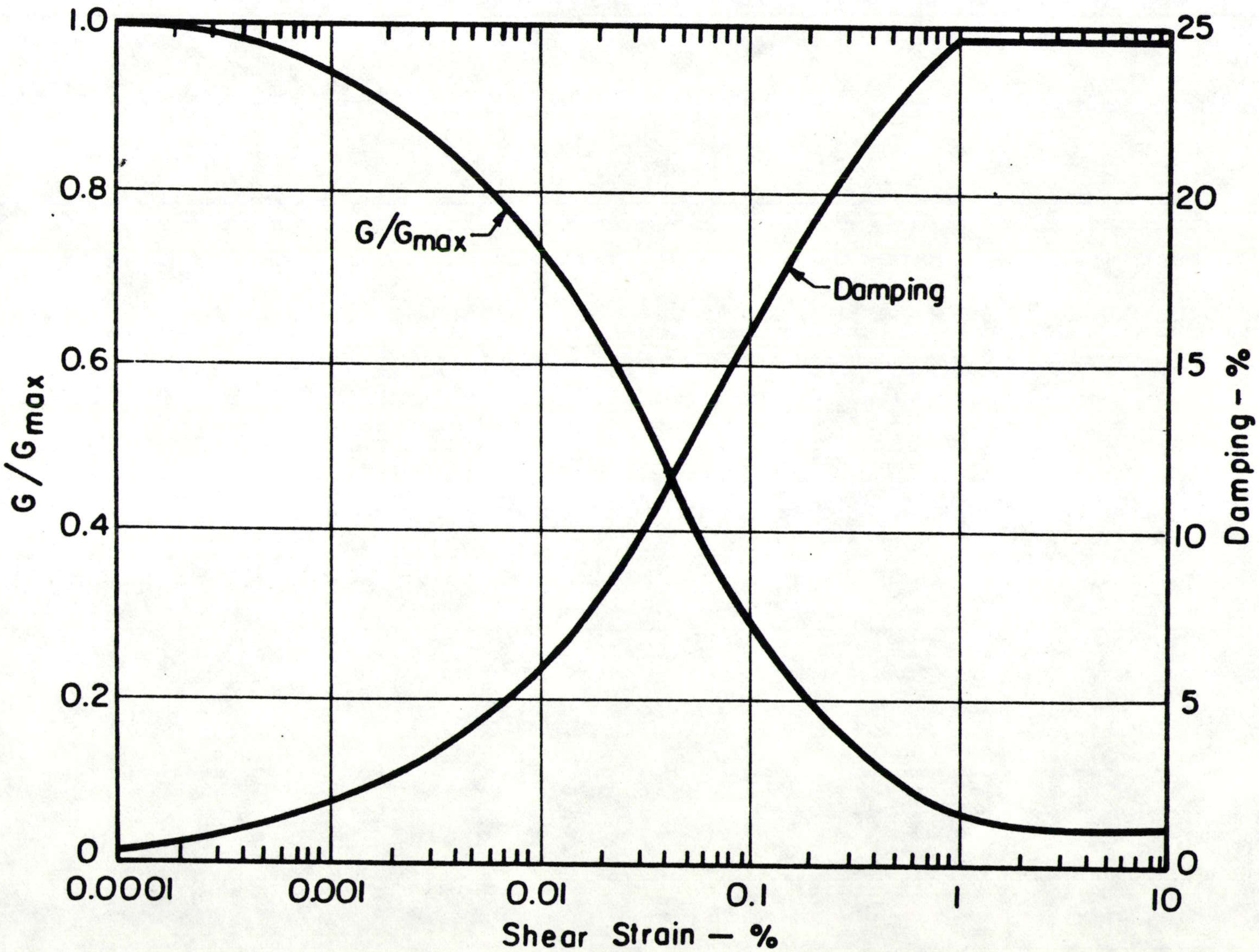



FIG. 18 SHEAR MODULUS AND DAMPING CHARACTERISTICS USED IN RESPONSE COMPUTATIONS

y is measured from the crest,

h is the total dam height

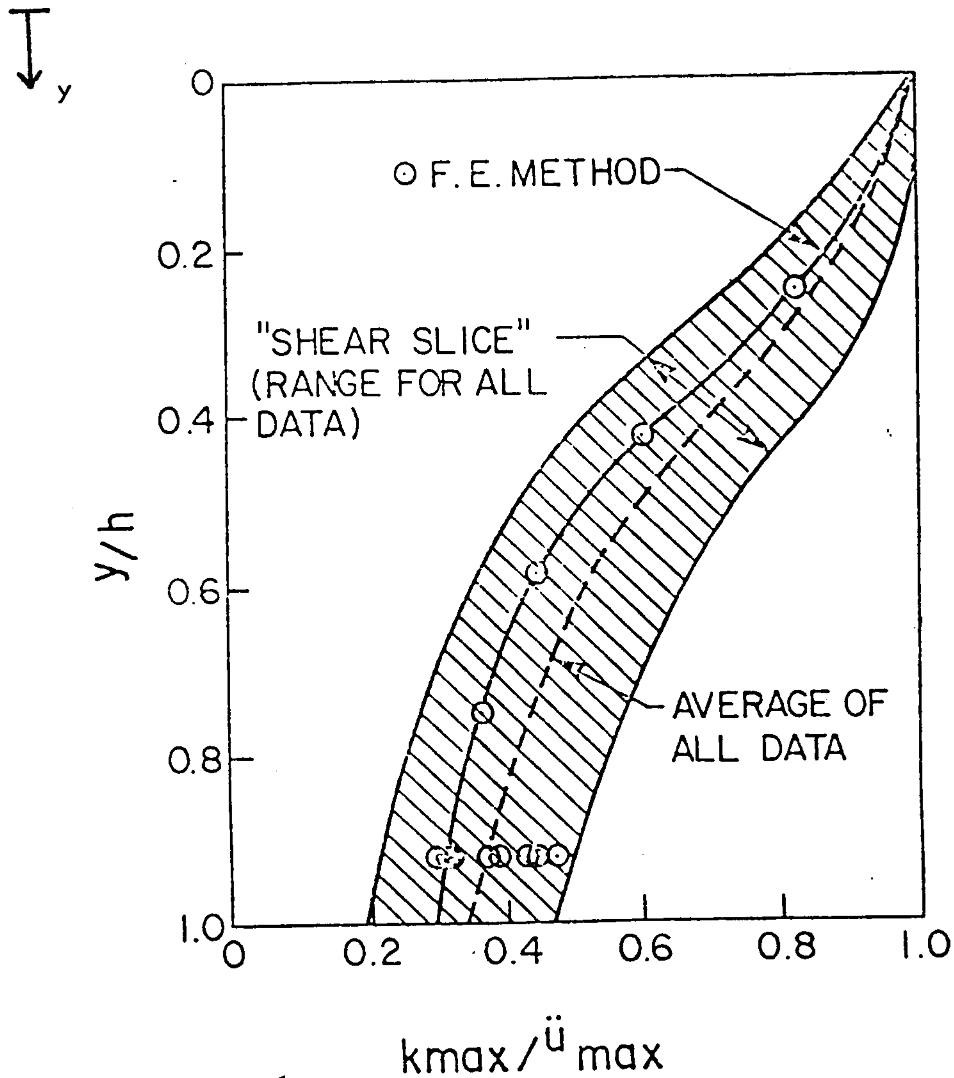
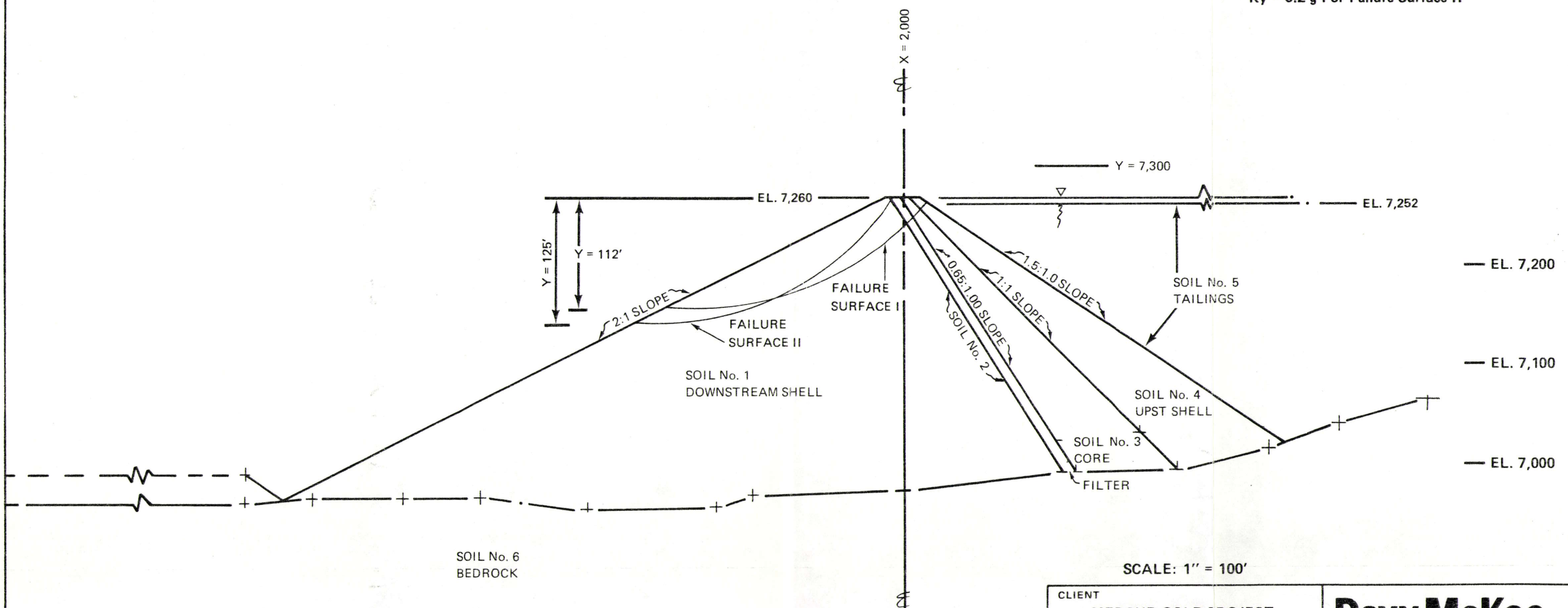



Figure 19 Variation of average maximum acceleration, K max., with depth below the dam crest, after Makdisi and Seed (1978).

| SOIL ZONE | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| $\gamma_T$, UNIT WT., pcf | 125 | 130 | 120 | 130 | 100 | 150 | N/A |
| c, COHESION, psf | 0 | 0 | 400 | 0 | 0 | 9,000 | N/A |
| $\phi$, PHI ANGLE, DEG. | 35 | 35 | 18 | 30 | 0 | 30 | N/A |

Ky = Yield Acceleration
Ky = 0.21 g For Failure Surface I
Ky = 0.2 g For Failure Surface II




SCALE: 1" = 100'

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| TITLE: RESERVATION CANYON DAM<br>STAGE III<br>DEFORMATION ANALYSIS | SCALE: FIGURE 20 | REV. |

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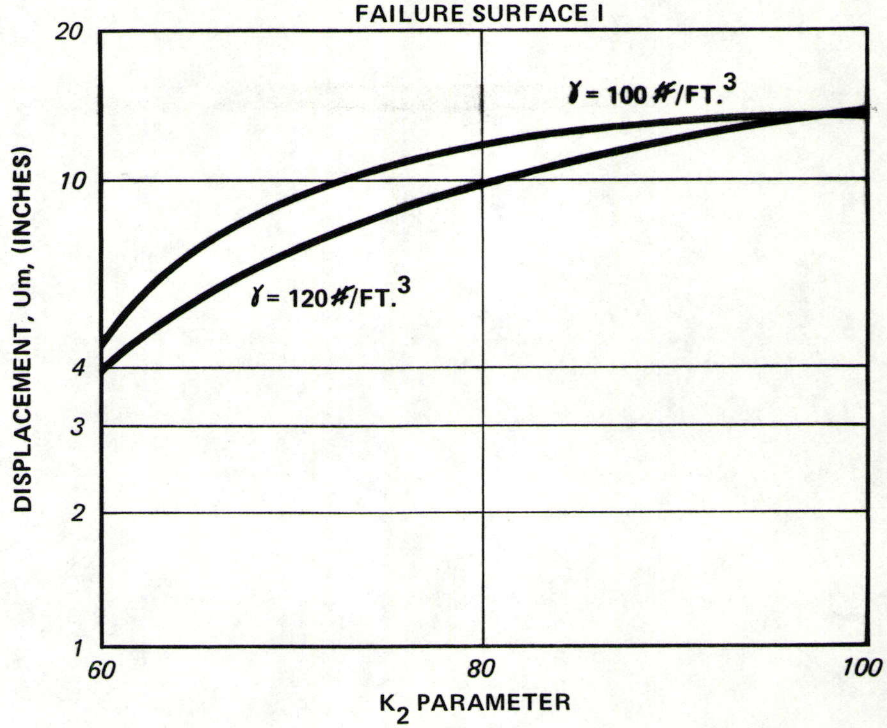
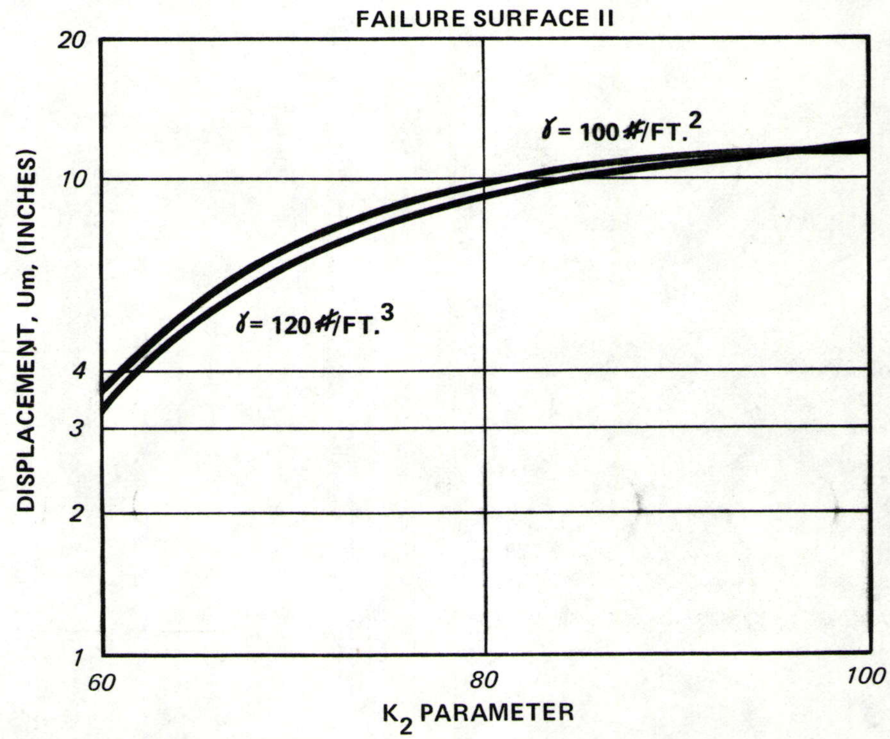
S ENG-28 REV. 10/79

ESTIMATED PERMANENT DEFORMATIONS
DUE TO WASATCH FRONT EARTHQUAKE




MAXIMUM ACCELERATION IN ROCK = 0.25g
EMBANKMENT HEIGHT = 260 FT.

FIGURE 21A

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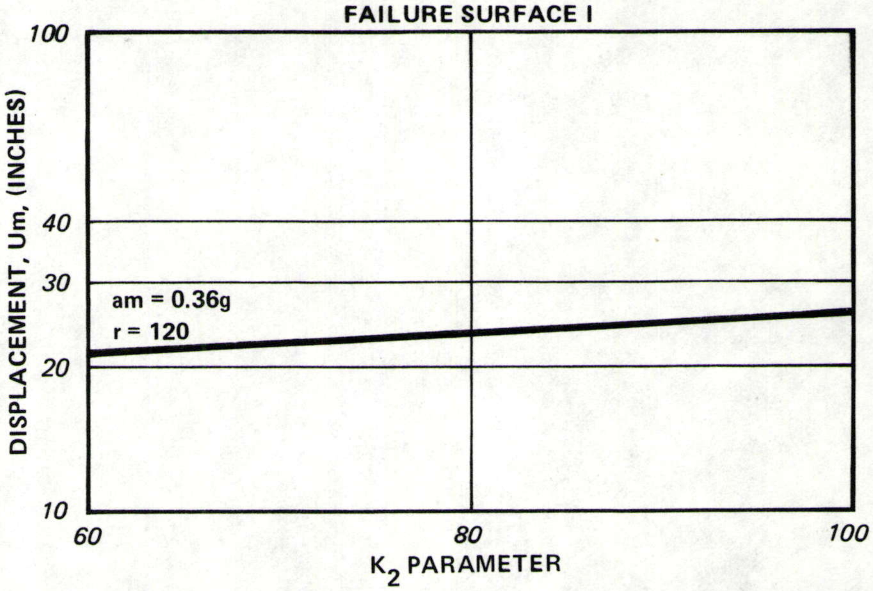
ESTIMATED PERMANENT DEFORMATIONS
DUE TO WEST MERCUR FAULT EARTHQUAKE



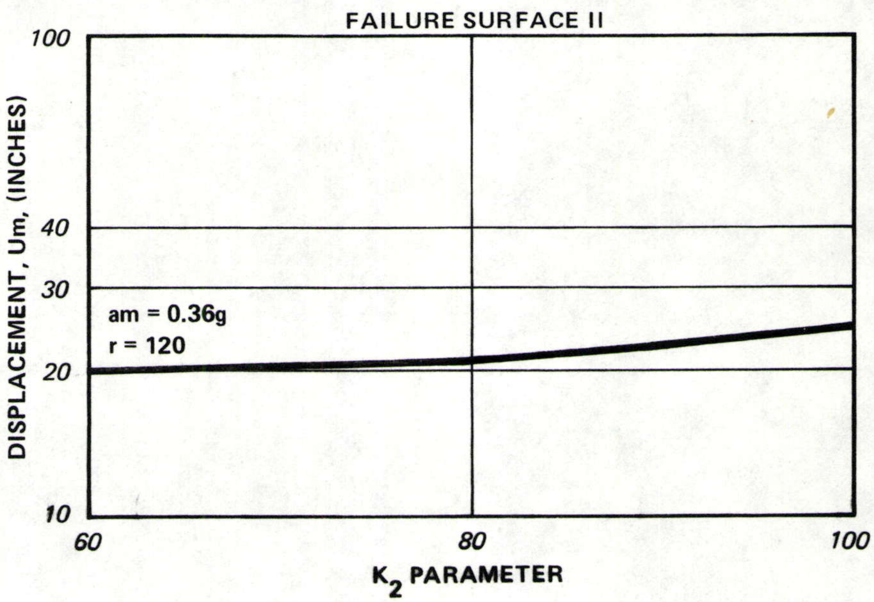




FIGURE 21B

TABLE 4
SLOPE STABILITY CASES
AND
APPLICABLE SHEAR STRENGTH PARAMETERS

| Case | Design Condition | Source for Shear Strength Parameters | |
|---|---|---|---|
| I | End of construction | Core material strength was determed from unconsolidated undrained triaxial tests. Shear strength parameters for shell and filter materials were estimated from experience with similar materials. | |
| II | Pseudo-Static Case I | The same parameters as Case I were used | A seismic coefficient equal to 0.1g was used upstream and downstream slopes analyzed. |
| IV | Steady seepage during maximum operating pool final stage. | Consolidated drained (effective stress) parameters were used. Shear Strength of core material was determined from ICU triaxial tests with pore pressure measurements. Shear strength parameters for shell and filter materials were estimated from experience with similar materials. | |
| V | Pseudo-Static Case IV | Consolidated undrained (total stress) parameters were used. Shear strength of core material was determined from ICU triaxial tests with pore pressure measurements. Shear strength parameters for shell and filter materials were estimated from experience with similar materials. | A seismic coefficient equal to 0.1g was used upstream and downstream slopes analyzed. |

As a result of the above analyses, a maximum horizontal displacement of 12 inches is estimated for the design earthquake originating at the Wasatch Front. On the other hand, for the earthquake originated at the West Mercur fault, a maximum horizontal displacement of approximately 2.5 feet was estimated.

### 7.6 Inspection and Monitoring Program

Embankment construction inspection shall be under the direction of a qualified geotechnical engineer. It shall be designed to ensure that actual construction complies with the specifications and the resulting earth structure has properties congruent with design assumptions. Recommended routine density and classification tests for compaction and material quality control are shown in Table 5.

Generation of positive pore pressures during construction will be monitored using a network of pneumatic piezometers installed strategically in the core and other locations as shown in Figure 20. These piezometers will be used for long-term monitoring as well.

A limited number of surface monuments (See Figure 2) will be used to monitor displacements during and after construction.

7.0 EMBANKMENT ANALYSIS AND DESIGN (cont'd)

During construction, piezometers shall be read daily, and monuments shall be surveyed once a month. During operation, piezometers shall be read monthly and monuments quarterly. The data shall be reviewed by a qualified geotechnical engineer who shall send quarterly reports to Getty Mining Company. Site inspection shall be performed by the aforementioned engineer every six months and after a major storm or earthquake.

Table 5

| Test | Frequency of Tests per 1000 Cubic Yards | | | |
|---|---|---|---|---|
| | Core | Fine Filter | Coarse Filter | Shell |
| Field Density | 3 | 3 | 1/5 to 1/10 | 1/5 to 1/10 |
| Gradation | 1 | 5 | 5 to 10 | 1/5 to 1/10 |
| Atterberg Limits | 1 | | | 1/5 to 1/10 |
| Moisture Content | 3 | 3 | | 1/5 to 1/10 |
| Lab. Compaction | 3 | 1/5 | | (A) |

(A) As required due to variations of borrow material.

To check the shear strength of in-situ core material, undisturbed samples shall be taken from the embankment and tested under triaxial shear. In addition, in-situ tests may be performed on shell material. Should test results warrant it, the embankment will be re-analyzed.

Adequate construction specifications are given in General Specification No. GC-18, however, if the Contractor chooses he may perform a test fill in a manner satisfactory to the

7.0 EMBANKMENT ANALYSIS AND DESIGN (cont'd)

Engineer. Test results will help the Contractor and the Inspectors become familiar with the local materials as well as to approximately select:

a) The most effective type of compaction equipment.

b) The lift thickness and the number of passes of a given compacting equipment to achieve specified density.

c) The maximum particle sizes.

d) The amount of degradation or segregation occurring during compaction.

e) The physical properties of the in-place fill, such as density and grain size distribution.

Based on the results of the test fill, the Engineer will revise compaction requirements, if appropriate.

# 8.0 HYDROLOGY

## 8.1 General

The general area is mountainous terrain with slopes ranging from 5 to 50 percent. Vegetation native to the area is pinyon pine, juniper, oakbrush, big sagebrush, black greasewood and some aspen. The principal uses are range and wildlife habitat.

The elevation of the dam site is above 7000 feet, hence much of the annual precipitation is in the form of snow. The annual precipitation is approximately 17 inches, and the annual evaporation is about 42 inches. In general, evaporation is higher than precipitation at all times of the year except in December and January.

### 8.1.1 Surface Water

The total area of the drainage basin and the impoundment is small, approximately 788 acres. Reservation Canyon heads from the Oquirrh Mountains and joins Meadow Canyon from the northwest as a tributary to Mercur Creek. Both Reservation and Meadow Canyons are ephemeral streams which flow in response to thunderstorm and spring snowmelt. The confluence of these two natural drainage channels is situated just north of the plant site and mine area.

8.0 HYDROLOGY (cont'd)

Because of the steep topography and relatively short time lag, runoff from flash floods requires special attention to the peak flow used to design any conveyance structure.

8.1.2 Ground Water

Drilling and other subsurface exploration activities reveal that no shallow ground water aquifer is encountered in the area. A few springs occur at higher elevation above 7300 and discharge in direct response to snow melt and storms as interflow. The general direction of ground water movement in the vicinity of the site would be downdip northeasterly toward the southeast plunging pole Canyon Syncline, and then southeasterly toward Cedar Valley.

8.2 Hydrologic Design of Tailings Impoundment

The impoundment is designed to store 1/2 of the PMF (Probable Maximum Flood) volume, in addition to the tailings volume deposited during the 12 year operation of the mill.

The PMF is derived from PMP (Probable Maximum Precipitation) 24-hour duration which is 10.5 inches obtained from U.S. Weather Bureau (1960).

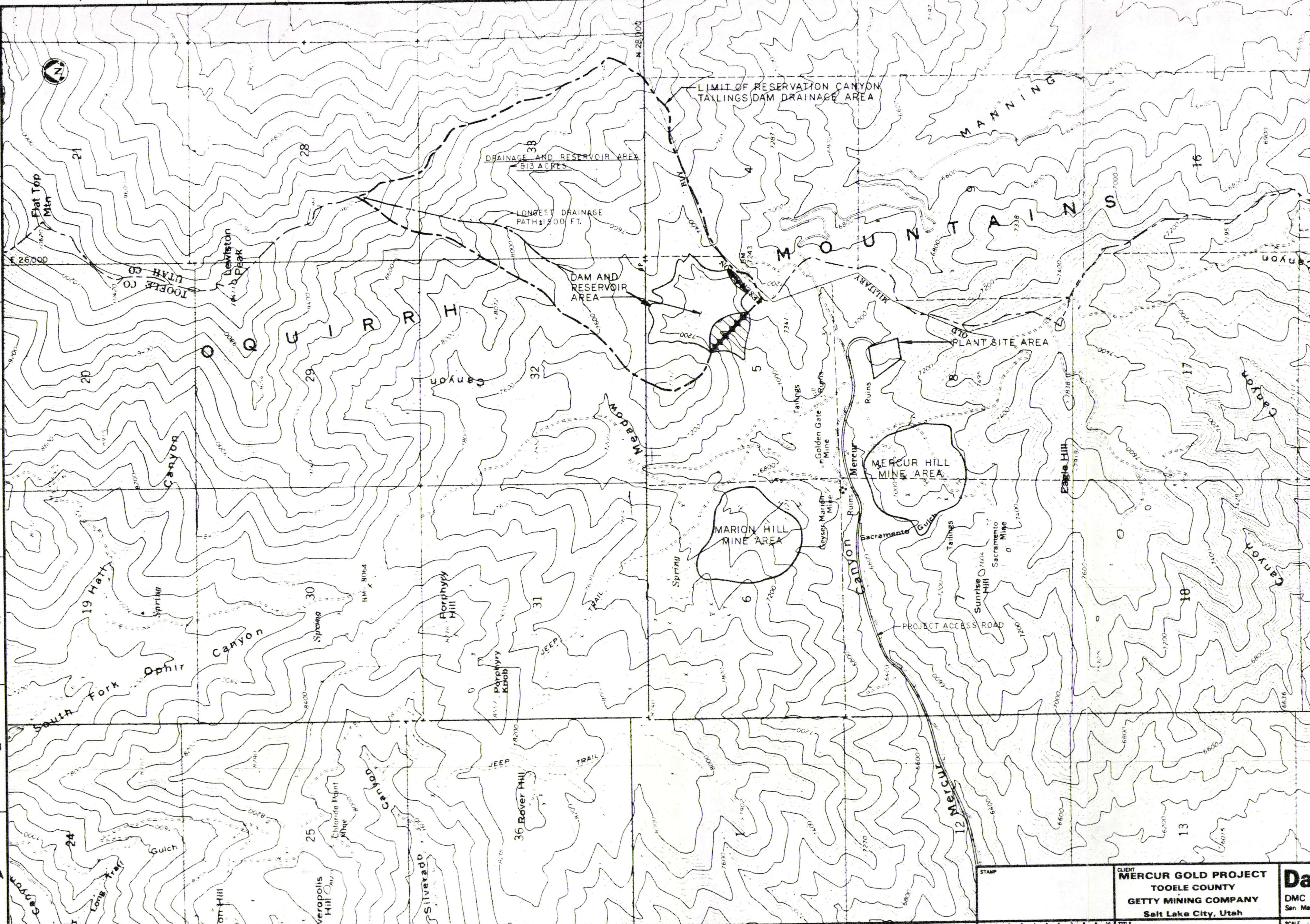



FIGURE 22

| | |
|---|---|
| CLIENT | MERCUR GOLD PROJECT<br>TOOELE COUNTY<br>GETTY MINING COMPANY<br>Salt Lake City, Utah |
| | Davy McKee<br>DMC Engineers and Constructors<br>San Mateo, California |
| TITLE | RESERVATION CANYON<br>TAILINGS DISPOSAL DAM<br>PLAN OF SITE-DRAINAGE AREA |
| SCALE | 1" = 1000' |
| DRAWING No. | SC2385 A<br>80-22-002<br>SHEET 2 OF |
| REVISION | 1 |

| NO. | DESCRIPTION | BY | CH. | APPROVED | DATE |
|---|---|---|---|---|---|
| 1 | Issued for Approval | | | | 2-1-84 |

DESIGNED: | DRAWN: EG | CHECKED | APPROVED 1 | APPROVED 2 | APPROVED 3

DATE TO: CLIENT 4/ | FIELD CC-12 3/4 | MICROFILM

DRAWING NO. 80-22-002

GAF Polytrace 044

## 8.0 HYDROLOGY (cont'd)

### 8.2.1 Runoff Volume

The total drainage area (including the tailings impoundment) is approximately 788 acres (1.23 sq mi). The watershed location and drainage boundary are shown on Figure 22. The drainage basin is uniformly covered by woodland type of vegetation with occasional barren spots. Assuming hydrologic soil of B type and an AMC II condition, an average curve number for the land portion of the drainage area is chosen to be 60. Since the impoundment area of approximately 75 acres (0.12 sq mi) comprises about 10 percent of the entire drainage area, the inflow volume was computed separately for the runoff from the land portion and the precipitation falling directly on the pond surface.

The excess runoff from the PMP 24-hour storm is obtained based on the curve number which is a measure of the infiltration potential of the drainage area. The volume of PMF from the land portion is found to be 13.7 million cu ft The volume of PMF accumulated in the pond from rainfall falling directly on the pond is 2.8 million cu ft.

8.0 HYDROLOGY (cont'd)

The 1/2 PMF volume storage required in the impoundment is half the sum of the excess runoff for the land and pond portion of the drainage basin which is 16.6 million cu ft. The computation of the runoff volume is presented in Appendix D.

A freeboard of at least 2.4 feet is required based on a surface area of 3.5 million sq ft at elevation 7260 ft above mean sea level. The freeboards required to store 1/2 PMF at different stages of tailings dam construction are presented in Table 7. The inflow volumes for the 10-year, 100-year storm and 1/2 PMF are shown in Table 6.

TABLE 6

Inflow Volumes for different 24-hr Storms

| Recurrence Interval | Total Volume to Impoundment x 10 6 (ft3) |
| --- | --- |
| 10 - yr | 0.554 |
| 100 - yr | 3.70 |
| 1/2 PMF | 8.30 |

TABLE 7

FREEBOARD REQUIREMENTS

| Stage | Pool Elevation | Surface Area x 10 6 (ft) | Freeboard (ft) Required to Store 1/2 PMF (8,296,248 ft3) | Wave Protection (ft) 1.5 x Wave height at 30 mph Wind velocity | Total Freeboard (ft) (Storm and Wave Protection + 4 ft Frost Protection) |
|---|---|---|---|---|---|
| 2 yr | 7165 | 1.18 | 7.0 | 1.0 | 12.0 |
| 6 yr | 7215 | 2.32 | 3.6 | 1.2 | 8.8 |
| 12 yr | 7260 | 3.50 | 2.4 | 1.2 | 7.6 |

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# APPENDIX A

General Specification GC-18

For

Reservation Canyon Tailings Dam

PROJECT NO. 2385A

# MERCUR GOLD PROJECT

## GETTY MINING COMPANY

## Salt Lake City, Utah

GENERAL SPECIFICATION GC-18

FOR

RESERVATION CANYON TAILING DISPOSAL DAM

DAVY McKEE CORPORATION
2700 CAMPUS DRIVE
SAN MATEO, CALIFORNIA 94403

Owner Approval: ____________________

Date ____________________

| REV. | DATE | BY | CHK. | APPROVAL | DESCRIPTION |
|---|---|---|---|---|---|
| A | 2-4-82 | JLV | | Dw | ISSUED FOR APPROVAL & CC-12/CC-20 |
| B | 2-23-82 | JLV | | Dw/JLV | Issued For Approval & [illegible] |
| | | | | | |
| | | | | | |
| | | | | | |

Contract No. 2385A
General Specification No. GC-18

INDEX

## 1.0 GENERAL

1.1 This specification covers the requirements for the construction of the Reservation Canyon Tailing Disposal Dam for the Mercur Gold Project as it is indicated on the drawings and as specified herein.

1.2 The State Engineer or a duly authorized representative from the State Engineer's office has full authority to inspect the construction at any time.

## 2.0 APPLICABLE CODES

2.1 Except as noted within this specification all work shall conform to the documents listed below. These documents are declared to be a part of this specification the same as if fully set forth herein:

All Federal, State and County regulations as they apply.

2.2 Wherever they are referred to in this specification the documents listed below are declared to be part of this specification the same as if fully set forth herein:

American Society for Testing Materials

ASTM D-698-70 Mositure-Density Relations of Soil and Soil Aggregate Mixtures Using 5.5 lb. Rammer and 12 inch Drop.

ASTM D-2049-69, Relative Density of Cohesionless Soils

ASTM D-1557-70 Mositure-Density Relations of Soils Using 10 lb Rammer and 18 inch Drop.

ASTM C131-76 Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine.

ASTM C535-69 Resistance to Abrasion of Large Size Coarse Aggregate by Use of the Los Angeles Machine.

ASTM C88-76 Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.

2.0 APPLICABLE CODES (cont'd)

Department of the Army

EM1110-2-1906 "Laboratory Soils Testing" November 30, 1970, Chapter 1 May 1 1980.

3.0 SUBSURFACE CONDITIONS

3.1 The following geotechnical reports have been prepared and are available for inspection at the San Mateo office of Davy McKee.

3.1.1 Report of Preliminary Tailings Dam Study, Dames & Moore, Oct. 12, 1981.

3.1.2 Basic Geotechnical Data Report, Reservation Canyon Dam Site, Mercur Gold Project, Tooele County, Utah, Woodward-Clyde Consultants, Jan. 15, 1982.

3.1.3 Preliminary Geological Report Potential Borrow Sources, Reservation Canyon and Meadow Canyon Dam Site, Mercur Gold Project, Tooele County Utah, Woodward-Clyde Consultants Jan. 4, 1982.

3.1.4 Preliminary Geological Report, Reservation Canyon Dam and Reservoir,Mercur Gold Project, Tooele County, Utah.

3.1.5 In-Situ Density Testing Reservation Canyon and Meadow Canyon Dam Site, Mercur Gold Project, Woodward-Clyde Consultants Jan. 27, 1982.

3.1.6 Geotechnical Report, Tailings Dam, Reservation Canyon, Mercur Gold Project, Davy McKee, February 1982.

4.0 CLEARING AND GRUBBING

4.1 The area to be occupied by the permanent construction required under these specifications and the surfaces of all borrow pits shall be cleared and grubbed of all trees, stumps, roots, brush, and other deleterious materials as determined by the Engineer.

4.2 Top soil from the foundation, borrow or impoundment areas shall be stored in zones designated by the Engineer. Removed combustible material shall be burned in accordance with all applicable laws and rules, or buried outside the dam area.

## 5.0 EXCAVATION

5.1 The complete tailings dam foundation shall be on competent rock as determined by the engineer, and as shown on the drawings.

5.2 Excavation areas shall be graded and properly maintained to insure adequate drainage at all times. Any depressions or irregularities shall be filled and compacted. Work shall be suspended when it is wet, muddy, or otherwise in such condition that the area cannot be properly manipulated.

5.3 Excavated material, not approved for use in the embankments by the Engineer, shall be disposed of in spoil areas designated by the Engineer.

5.4 Core and Filter Foundation Contact and Abutment Preparation.

5.4.1 The core and filter foundation and abutment excavations shall be made in such a manner as to expose a suitable foundation surface consisting of competent limestone or Manning Canyon Shale as approved by the Engineer.

5.4.2 During excavations, rainfall runoff and ground water shall be kept drained by ditching, sumping and pumping or other suitable methods.

5.4.3 Dimensions of the core and filter foundation and abutment excavations shall be as indicated on the drawings or as specified herein. The maximum slope at abutments shall be 0.5 horizontal to 1 vertical. In extreme cases, the following slopes may be allowed: 0.25 horizontal to 1 vertical for heights less than 10 feet.

5.4.4 Side slopes shall be reasonably smooth and uniform and shall be cleaned of all loose and protruding material. Overhangs and reversed slopes shall be eliminated. No vertical walls shall be allowed in abutments. Sharp corners of rock strata shall be bevelled off to avoid sharp, protruding angles in the core.

5.4.5 All loose or detached rock, as well as soft erodible seams and pockets of earth shall be removed from the foundation and abutments (this may require use of hand methods, picking, barring, and wedging and/or other suitable means). Loose materials may be found in cracks or joints. All cracks and/or joints shall

5.0 EXCAVATION (cont'd)

be cleaned out to 3 times their maximum width or to a depth of 6 inches, whichever is greater. Subsequently, they shall be filled with grout.

B 5.4.6 The grout shall consist of a 1:1 (by volume) water-cement mixture.

5.4.7 Prior to the placement of any filter material and/or any impervious core material the foundation shall be blown clean using blow pipes and compressed air".

B 5.4.8 Placement of impervious core material and/or filter material shall take place within 24 hours of air cleaning the foundation or abutment and/or after approximately one hour after placement of the grout coating.

B 5.4.9 Foundation rock shall not be exposed for longer than one day.

6.0 FOUNDATION DEWATERING

6.1 In the event water is found, dewatering procedures shall be followed.

6.2 Prior to beginning work on dewatering the foundation, the Contractor shall submit for approval a plan showing his proposed method. The plan may be placed in operation upon approval, but nothing in this section shall relieve the Contractor from full responsibility for the adeauacy of the system.

6.2 The dewatering shall be accomplished in a manner that will result in all construction operations being performed in the dry.

7.0 BORROW

7.1 The materials required for construction may be obtained from the foundation excavation and from the borrow areas shown on the drawings. Coarse and fine filter material shall be provided by the contractor.

7.2 The type of equipment used and the excavation of material in the borrow areas shall be such as will produce the required uniformity of mixture of each of the types of materials specified.

## 7.0 BORROW (cont'd)

7.3 The contractor shall perform selective excavation of borrow material, as required by the Engineer.

7.4 The location and extent of all borrow pits within the borrow areas shall be as directed by the Engineer. The Engineer reserves the right to change the limits or location of borrow pits within the limits of the borrow area in order to obtain the most suitable material.

7.5 As far as practical, the material shall be conditioned in the borrow pit before hauling and placement on the embankment. When moisture is introduced into the soil at the borrow pit, care shall be exercised to mix the material uniformly to produce the required moisture during compaction, avoiding excess accumulation of water in the soil.

B

7.6 The Engineer will designate the depth of cut in all parts of the borrow area, and the cuts shall be made to such designated depths.

## 8.0 FILL MATERIALS AND THEIR BORROW SOURCES

8.1 Six types of materials shall be used in the embankment construction. They are shown in the following table:

B

| Zone | Zone Description | Material Description |
|---|---|---|
| I | Downstream Shell Cover | Limestone rock and limestone fragment |
| II | Downstream Shell | Clayey gravel, sandy gravel, and clayey to silty sand. |
| III | Coarse Filter - Drain | Gravel sand mixture |
| IV | Fine Filter | Fine to coarse sand |
| V | Impervious Core | Clayey silt to silty clay and decomposed shale |
| VI | Upstream Shell | Clayey gravel, sandy gravel, and boulders. |

8.0 FILL MATERIALS AND THEIR BORROW SOURCES (cont'd)

8.2 Zone I Material

This material may be obtained from borrow areas adjacent to the dam as shown on the drawings and as designated by the Engineer, and from the foundation excavation. All materials composed of mudstone, claystone, and siltstone shall not be used for construction of these zones. The materials shall be free of vegetation debris, organic matter, and other deleterious materials. The maximum particle size shall be 12 inches.

8.3 Zone II material shall consist of clayey gravel, sandy gravel, and clayey to silty sand. The maximum particle size shall be 8 inches. This material may be obtained from the foundation excavation and/or from the overburden overlying Zone V material in the impondment area. This material shall be free of roots, organics, and other deleterious materials.

8.4 Zone III material shall meet the following requirements:

| Sieve Size (Square Openings) | Percent Passing by Weight |
|---|---|
| 3 inch | 100 |
| 3/8 inch | 90 to 50 |
| No. 8 | 50 to 10 |
| No 16 | 30 to 5 |
| No. 100 | 8 to 0 |
| No. 200 | 5 to 0 |

In addition, the fines (-200 size material) shall be cohesionless, and the Los Angeles Abrasion Loss (500 revs) shall be 40 percent or less.

8.5 Zone IV material shall meet the following requirements:

| Sieve Size (Square Openings) | Percent Passing by Weight |
|---|---|
| 3/8 inch | 100 |
| No. 4 | 100 to 84 |
| No. 16 | 84 to 46 |
| No. 50 | 50 to 18 |
| No. 200 (fines) | 16 to 5 |

8.0 FILL MATERIALS AND THEIR BORROW SOURCES (cont'd)

In addition, the fines (-200 sieve material) shall be cohesionless.

8.6 Zone V material shall consist of relatively soft shale and clay found in the impoundment borrow area. In addition, clay material found in the foundation excavation may also be used for core material. The material for Zone VI shall be free of roots, organics and other deleterious materials. The following are the gradation requirements:

| Particle Size | Percent Passing by Weight |
|---|---|
| 3 inches | 100 |
| 3/4 inch | 98 to 76 |
| No. 4 | 86 to 46 |
| No. 30 | 68 to 34 |
| No. 200 | 52 to 25 |

In addition, the Plasticity Index shall be greater than 15.

8.7 Zone VI Material

This material may be obtained from borrow areas adjacent to the dam (as shown on the drawing) as designated by the Engineer, and from the foundation excavation. All materials composed of mudstone and claystone shall not be used for construction of this zone. The materials shall be free of vegetation debris, organic matter, and other deleterious materials. In addition, the finer material shall be placed adjacent to the core. The coarser material (more rock like) available in the borrow-pit and/or the foundation excavation shall be selected for this zone. The maximum particle size shall be 12 inches. A minimum of 70 percent by weight of the material shall be retained in the No. 4 Sieve.

## 8.0 FILL MATERIALS AND THEIR BORROW SOURCES (cont'd)

8.8 The placement of all fill materials are subject to the approval of the Engineer.

## 9.0 EMBANKMENT

9.1 The suitability of each part of the foundation for placing embankment materials thereon, and of all materials for use in embankmant construction, shall be determined by the Engineer.

9.2 In any separate portion of dam being constructed, each layer of each zone shall be constructed continuously and approximately horizontal for the width and length of such portion at the elevation of the layer.

9.3 The distribution and gradation of the material throughout the earthfill shall be such that the fill will be free from lenses, pockets, streaks, or layers of material differing substantially in texture, gradation, or moisture from the surrounding material. In addition, the more pervious materials shall be placed toward the outer slopes of the embankment.

9.4 If, in the opinion of the Engineer, the surface of the layer of earthfill is too dry or smooth to bond properly with the layer of material to be placed thereon, it shall be moistened and/or worked with harrow, scarifier, or other suitable equipment, in an Engineer approved manner to a sufficient depth to provide a satisfactory bonding surface before the next succeeding layer of earthfill material is placed.

9.5 The surface of each lift or layer shall be approximately horizontal, but after compaction shall have sufficient slope to provide for runoff of surface water. At no point on the dam or dike embankment shall any ponding of water be allowed at anytime. If, as a result of rainfall or any other cause of excessive moisture, the embankment working surfaces become saturated and are unsuitable, the materials shall be removed from the surface, to such depths as may be required by the Engineer, to expose firm compacted materials before resuming the fill placement and compaction operations.

9.0 EMBANKMENT (cont'd)

9.6 Because the embankment shall be built in stages, it will be necessary, as directed by the Engineer, to remove and scarify material from the downstream slope and crest of the embankment. This shall ensure adequate bondage between new and old fill. Care shall be taken to remove and recompact old fill damaged by frost penetration. In addition, should vegetation or other deleterious material be found, this shall be removed in a manner approved by the Engineer.

9.7 The excavation and embankment construction work will be carried out under the supervision of the Engineer.

9.8 Additional embankment quality control tests may be performed for the Engineer by an appointed subcontractor or directly by the Engineer. These tests shall comply with the Inspection and Quality Control Specification.

9.9 No fill shall be placed over any area where tests are in progress until the tests have been reported and the Engineer has advised the Contractor that it may continue.

9.10 Equipment contaminated with fine grain soil shall not be allowed to run over the fine and coarse filter zones (zones III and IV).

9.11 Zones II, V and VI material shall be gently sloped (1 to 5 percent) so as to direct runoff away from the fine and coarse filters (Zones III and IV), thus preventing fines from contaminating the filters.

9.12 The downstream horizontal drainage zone shall be completely placed and covered by two lifts of Zone II material as soon as possible to prevent contamination of the blanket by exposure of surface waters carrying fines.

9.13 Except when allowed by the Engineer, placement of coarse filter materials shall be kept higher than adjacent fine filter material, and placement of filter material in general shall be kept higher than adjacent fill to prevent contamination of filters.

9.14 Except as approved by the Engineer, compaction equipment shall comply with the requirements stated in "Civil Work Construction Guide Specification", CW-02212, Feb. 1976, Department of the Army, Corps of Engineers, Office of the Chief of Engineers.

## 10.0 COMPACTION

All the following compaction requirements shall be for in place materials.

### 10.1 Slope Protection - Zone I

Each layer shall be placed in lifts not exceeding 12 inches in loose thickness and compacted using 4 passes of a 10 ton or heavier vibratory roller.

### 10.2 Downstream Shell Material - Zone II

Each layer shall be compacted to a minimum of 98 percent of maximum dry density as determined by the "Compaction Test for Earth-Rock Mixtures" Department of Army EM 1110-2-1906, Appendix VI A.

### 10.3 Coarse Filter Material - Zone III

Each layer shall be placed in lifts not exceeding 12 inches in loose thickness. Compaction shall be with 4 passes of a 10 ton or heavier vibratory roller. No water content control is required and the material shall be compacted in its as-received condition.

### 10.4 Fine Filter Material - Zone IV

Each layer shall be placed in lifts not exceeding 8 inches in loose thickness and compacted to a minimum of 98 percent of maximum density as determined by ASTM D-698. The moisture content shall be kept within between 0 and 3 percent above optimum.

### 10.5 Core Material - Zone V

Each layer shall be placed in lifts not exceeding 8 inches in loose thickness compacted to a minimum of 98 percent of the maximum density as per ASTM D-698. Compaction shall be carried out using a sheepsfoot roller. Moisture content shall be kept within 0 to 3% above the optimum moisture content.

10.6 Zone VI Material

Each layer shall be compacted to a minimum 98 percent of the optimum dry density as determined by the "Compaction Test for Earth-Rock Mixtures" Department of Army EM 1110-2-1906 Appendix VI A.

10.7 Compaction requirements in this section may be modified at any later time as required for adequate compaction, as determined by the Engineer.

## 11.0 LIFT ELEVATIONS

11.1 The difference in elevation between points in the embankment shall be limited to 3 feet when measured in a direction perpendicular to the longitudinal axis of the dam. This applies to points within the same zone as well as points in any two different zones, except that the difference in elevation between points in Zone II and the other zones may be larger than 3 feet.

11.2 A portion of Zone II, the downstream shell, may be built ahead of the rest of the embankment. However, the Contractor shall provide the Engineer with specific plans to assure that fines carried in runoff from Zone II material are not allowed to contaminate the filters (Zones III and IV). Any contaminated filter material, as determined by the Engineer, shall be removed and new material shall be placed.

11.3 The approval of a construction plan by the Engineer shall not relieve the Contractor from the absolute and total responsibility to preclude contamination of the filters.

## 12.0 WEATHER LIMITATIONS

12.1 In no case shall frozen soils be placed in any portion of the embankment nor shall any fill materials be placed upon frozen embankment surfaces.

## 13.0 PROTECTION OF THE EMBANKMENT

13.1 It shall be the Contractor's responsibility to protect the embankment from freezing. Where required, this may be accomplished with the placement of dry lifts on the embankment at the end of each day of operation or by other methods approved by the engineer.

## 14.0 SLIDES

14.1 In the event of slides in any part of the embankment prior to final acceptance of the work, the Contractor shall remove material from the slide area, as directed, and shall rebuild such portion of the embankment. In case it is determined that the slide was caused through the fault of the Contractor, the removal and disposal of material and the rebuilding of the embankment shall be performed without cost to the Owner; otherwise this work will be paid for at the applicable contract unit prices for borrow excavation and compacted fill or backfill.

## 15.0 PIEZOMETERS AND MONUMENTS

15.1 Piezometers will be supplied by others and shall be installed on the embankment foundations by the Contractor. Fill around these devices shall be placed and compacted to the density prescribed for the class of the material being placed.

15.2 The Contractor shall furnish and install surface monuments as shown on the drawings. The Contractor shall furnish to the Engineer the horizontal and vertical location of each reference mark with respect to established bench marks at the time of installation and every seven calendar day thereafter until completion of the contract. The Contractor shall conduct his operations in such a manner that the reference marks will not be disturbed or damaged. Any reference mark disturbed or damaged due to negligence on the Contractor's part shall be replaced or repaired and the correct horizontal and vertical locations shall be furnished at the Contractor's expense.

# APPENDIX B

## Contract Specification

## Laboratory Testing

MERCUR GOLD PROJECT

GETTY MINING COMPANY

SALT LAKE CITY, UTAH

# CONTRACT SPECIFICATIONS

# LABORATORY TESTING - TAILINGS DAM

## 1.0 SCOPE

This specification covers the laboratory testing program for the Reservation Canyon Tailings Dam. Specifically, it covers the types of tests required to adequately determine engineering classification and other engineering properties of:

(a) Tailings

(b) Foundation materials

(c) Core material

(d) Fine filter

The subcontractor shall submit a comprehensive report of all tests specified herein.

## 2.0 DEFINITIONS

"Owner" when referred to, shall mean the Getty Mining Company.

"Contractor" when referred to, shall mean the Davy McKee Corporation. Alternatively, Contractor may be identified as DMC.

"Subcontractor" when referred to, shall mean the company performing the work under this Contract.

## 3.0 WORK INCLUDED

### 3.1 General

The Subcontractor shall arrange and pay for the selection and transportation of all soil samples with the exception of tailings and tailings liquor.

## 3.0 WORK INCLUDED (cont'd)

### 3.2 Applicable Codes or Testing Procedures

All tests shall be performed following ASTM specifications or where indicated following the Corps of Engineers Laboratory Testing Manual EM 1110-2-1906. Deviations from these procedures may be approved by the Contractor upon written request by the Subcontractor.

### 3.3 Field Sampling

The subcontractor is responsible for obtaining representative random samples of the materials tested. If, for example, two different sources are considered for core material, enough samples shall be tested to properly identify the properties of soils from each source.

### 3.4 Tests on Tailings Material

3.4.1 Gradation tests as per ASTM D 422-63. The Hydrometer analysis shall be included.

3.4.2 Falling Head Permeability Tests with Pressure Chamber as per EM 1110-2-1906 (30-11-70) on:

- Two samples prepared to have a total unit weight of 80 pcf.

- Two samples prepared to have a total unit weight of 110 pcf.

Use tailings liquor instead of distilled water when performing tests on all four samples.

3.4.3 Perform two sets of Atterberg limits, as per ASTM D423-66 and ASTM D424-59.

3.4.4 Perform one specific gravity test as per ASTM D854.

### 3.5 Tests on Core Material

3.5.1 Grain size distribution including Hydrometer analysis, as per ASTM 422-63; and Atterberg limits as per ASTM D423-66 and ASTM D424-59 on all materials tested in section 3.5.

3.5.2 Moisture density curves shall be performed on selected borrow material samples as per ASTM D 698-64T. Method to be selected by the Subcontractor after examination of the grain size distribution curve.

3.0 WORK INCLUDED (cont'd)

3.5.3 Moisture density curves shall be performed on selected borrow material samples as per ASTM D 1557-64T. Method to be selected by the Subcontractor after examination of the grain size distribution curve.

3.5.4 Dispersion tests shall be performed early during the testing program. These shall consist of:

(a) Pinhole tests

(b) Tests of soluble salts in pore water

(c) SCS laboratory dispersion tests

(d) Crumb tests

Follow procedures outlined in:

(a) "Identification and Nature of Dispersive Soils" by Sherard, et al (1976) ASCE GT4 April 1976

(b) "Pinhole Test for Identifying Dispersive Soils" by Sherard, et al (Jan. 1976) ASCE GT1

Alternatively, procedures from EM-110-2-1906, Change 1, May 1, 1980, Chapter XIII, may be used. The need for these tests shall be evaluated prior to their execution, should the soil be less than 12 percent by weight finer than 0.005 mm and should its plasticity index be $\leq$ 4.

3.5.5 Triaxial tests shall comply with the following requirements:

- The maximum particle size in the specimen shall be 1/6 of the sample diameter.

- The maximum sample diameter shall be approximately 3 inches.

The triaxial test procedures shall be as per EM 1110-2-1906 Appendix X. The compaction procedure is specified in Appendix X, Page X-14. Sample preparation is specified in Appendix VI, Page VI-4, Section 6.

Skempton's pore pressure parameters A and B shall be measured. The pore pressure parameter A shall be plotted vs. strain.

3.0 WORK INCLUDED (cont'd)

3.5.5.1 Perform ICU triaxial test with pore pressure measurements on samples compacted to the optimum moisture content. Develop one well-defined Mohr envelope for each of the following cases:

(a) Prepare samples to the maximum density as per ASTM D 698-64T and test by consolidating at effective pressures of 50, 100 and 150 psi. This case may be eliminated after review of compaction test results and upon DMC's approval.

(b) Same as in Case (a) but using 95% of maximum density according to ASTM D 1557-64T as a density criteria.

Depending on test results it will be possible to determine if requiring the more stringent compaction criteria will render significant gain in density and strength. Another consideration is the decrease in plasticity of the core due to the higher compactive effort (lower optimum moisture content). Core cracking is important, particularly in sloping core dams.

After review of the preceding laboratory test results, the subcontractor and the contractor shall meet to select the moisture content and density for the samples prepared for the subsequent tests of this section.

3.5.5.2 Perform Unconsolidated Undrained (UU) tests at the following cell pressures (core material not expected to be a perfect clay.):

| | |
|---|---|
| Test 1 | 25 psi |
| Test 2 | 50 psi |
| Test 3 | 100 psi |
| Test 4 | 150 psi |

3.0 WORK INCLUDED (cont'd)

3.5.5.3 Perform consolidated undrained triaxial tests with pore pressure measurements as per EM-1110-2-1906, Appendix X. Two sets of tests will be performed, one set at each of the following principal effective consolidation stress ratios: Kc = 1.5, 2.0.

3.5.6 Perform consolidation tests on saturated core samples; test per EM 1110-2-1906, Appendix VIII. As a guide, a maximum loading of 250 psi is suggested.

3.5.7 Specific gravity tests as per ASTM D854, shall be performed on all materials tested.

3.5.8 Perform falling head permeability tests with pressure chamber as per EM 1110-2-1906 Samples shall be compacted as per Appendix X, Page X-14, Section 2. In addition, two tests shall be performed using tailings liquor.

3.6 Tests On Fine Filter Material

3.6.1 Grain size distribution including Hydrometer analysis, as per ASTM 422-63.

3.6.2 Determine the maximum and minimum densities of this material following ASTM D 2049-69.

3.6.3 Perform falling head permeability tests as per EM 1110-2-1906, Chapter VII. Samples shall be compacted to 75, 80, and 85 percent relative density. The compaction procedure shall comply with paragraph 4b, Page X-16, Appendix X, EM-1110-2-1906.

3.7 Tests on Foundation Materials

As a result of the Field Investigation, the Subcontractor was requested to perform field density tests, of the sand cone type, to evaluate the suitability of these materials as a foundation material. Gradation tests, as per ASTM 422-63, shall accompany the test results. In addition, areas with different types of foundation materials are clearly indicated in a plan of the dam foundation at both the Reservation and Meadow Canyon Sites. These tests have been performed under Amendment 1.

3.0 WORK INCLUDED (cont'd)

3.8 Report

A comprehensive report of all test results shall be presented to the Contractor for his review and comment prior to printing of the final report.

Triaxial test results shall include, but not be limited to, the presentation of plots of deviator stress versus axial strain, pore pressure versus strain, pore pressure parameter A versus strain. Both, stress path plots and Mohr envelopes shall be presented for total and effective stresses, as applicable.

Consolidation test results shall include, but not be limited to plots of void ratio versus log of effective consolidation pressure, and settlement versus the log of time.

All data sheets and back-up calculations not shown in the report shall be organized in a binder and submitted to the Contractor.

One sample calculation of each type shall be clearly presented at the beginning of each set of calculations. Appropriate references shall be listed.

A minimum of 20 copies of the final report shall be submitted.

4.0 WORK EXCLUDED

Excluded from the scope of work of the Subcontractor is the procurement of tailings and tailings liquor samples. The Contractor shall supply these samples in the quantities requested by the Subcontractor. A written request shall be delivered to the Contractor within one week of the date of this agreement.

5.0 DEADLINE

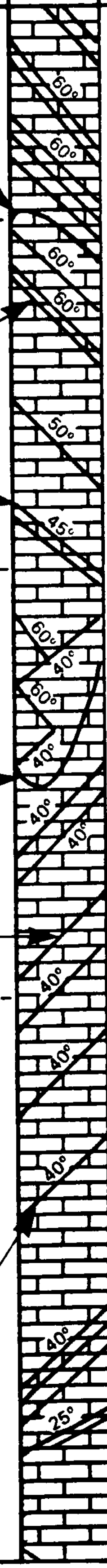
The deadline for submission of the final report shall be February 15, 1981.

Project No. 15141A    Log of Boring No. BH-3    

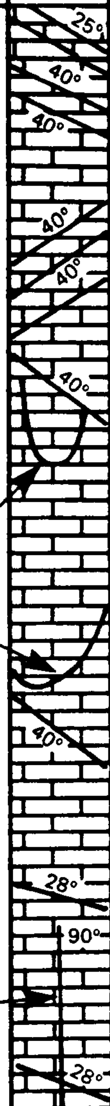
| | |
|---|---|
| BORING LOCATION | RESERVATION CANYON, UTAH |
| ELEVATION AND DATUM | 7142, MSL |
| DRILLING EQUIPMENT | MOBILE B-80 |
| DATE STARTED | 10-24-81 |
| DATE FINISHED | 10-27-81 |
| DRILLING METHOD | ROTARY, MUD: SD-300 |
| COMPLETION DEPTH | 44' |
| ROCK DEPTH | 3.7' |
| SIZE AND TYPE OF CASING | BOYLER, HQ, 3-9/16" O.D., 3.6' |
| WATER ELEV. | FIRST / COMPL. / 24 HRS |
| CORE BARREL TYPE | NQ - WIRELINE |
| LENGTH | INNER BARREL: 10'<br>OUTER BARREL: 13' |
| LOGGED BY | 0 - 3.7' = N. THOMSEN<br>3.7 - 44' = K. MALEK |
| SAMPLER/HAMMER | N/A |
| WEIGHT | N/A |
| DROP | N/A |

| DEPTH (feet) | DESCRIPTION | ROCK CORE: Sketch | Recov. % | RQD | Piezometer Data | SAMPLES: Type No. | Recov. % | Penetra. Resist. (Blows/6 in.) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 0 – 3.7 | GRAVEL, GW, brown, medium dense, some sand, trace clay | | | | | not sampled | | | Tricone bit to 3.7'-3.6' of casing dropped 0.4' of casing out |
| 2 – 4.5 | LIMESTONE, Very dark gray, very fine grained, moderately weathered with iron oxide along bedding, occasional calcite filling fractures (bedding ?) | 30° | | | | | | | |
| 4.5 – 5.5 | Very close to close (<1') fracture spacing | | | | | | | | Fracturing of core occures along 30%-50% dipping planes, which are usually iron oxide (hematite) stained, and most likely are bedding planes |
| 3.7 – 8 | | 30°, 30° | 100% | 86 | | continous coring | | | |
| 8 – 11 | LIMESTONE, Very close (<1') fracture (bedding), spacing, moderately weathered, iron oxide stain along weathered bedding<br>75% dip calcite filled, very thin (<1/16") healed fracture | 30°, 30°, 30° | | | | | | | |
| 11 – 12 | Close (<1') fracture spacing, with iron oxide stain in the fracture | 45° | | | | | | | 11', 90% circulation lost at 11', had to add some shreaded paper to regain circulation |
| 12 – 14 | LIMESTONE, Moderate close (<3') fracture spacing<br>Thin (<0.5"), iron oxide filled fracture | 50°, 50° | 100% | 80 | | | | | |

| DEPTH (feet) | DESCRIPTION, Cont'd | ROCK CORE Sketch | ROCK CORE Recov. % | ROCK CORE RQD | Piezometer Data | SAMPLES Type No. | SAMPLES Recov. % | SAMPLES Penetra. Resist. (Blows/6 in.) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 15–17 | LIMESTONE, Close (<1%) joint spacing, calcite, and iron oxide fracture stained<br>60% dip, very thin (<1/16") calcite filled fracture | | 100% | 80 | | | | | Coring rate 6'/83 min. |
| 17–21 | LIMESTONE, Close (<1.5') joint spacing<br>60% dipping, thin (<1/8") calcite filled fracture<br>Wide fracture (<1") stained with iron oxide | | 98% | 80 | | | | | Coring rate 4'/62 min. |
| 21–26 | LIMESTONE, Close (2"-12") joint spacing, calcite, and iron oxide stained fractures<br>Very thin (<1/16") fracture healed with calcite, dipping ∿70%<br>LIMESTONE, Open fracture (∿1/2"wide) filled with red silty medium-coarse sand size limestone fragments | | 95% | 73 | | | | | Coring rate 5'/25 min. ∿25.5' noticed caving |
| 26–32 | LIMESTONE, Moderately close to close (2"-36") fracture spacing, moderately weathered<br>Thin (∿1/2"wide) band of red silt dip ∿40° | | 99% | 82 | | | | | Coring rate 10'/34 min. |



Project No. 15141A    Log of Boring No. BH-3, Cont'd    Sheet 3 of 3

| DEPTH (feet) | DESCRIPTION, Cont'd | ROCK CORE Sketch | ROCK CORE Recov. % | ROCK CORE RQD | Piezometer Data | SAMPLES Type No. | SAMPLES Recov. % | SAMPLES Penetra. Resist. (Blows/6 in.) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 33 | |  | | | | | | | |
| 34 | | | | | | | | | |
| 35 | | | | | | | | | |
| 36 | | | | | | | | | |
| 37 | LIMESTONE, Thin (∿1") band of red silt filling the fracture, and thin (∿1/16") calcite band | | | | | | | | The bedding planes are approximately dipping 40° |
| 38 | Very thin (<1/16") healed fracture filled with calcite dip ∿80° | | | | | | | | |
| 39 | Very thin (∿1/16") healed fracture filled with calcite dip ∿75° | | 100% | 70 | | | | | |
| 40 | | | | | | | | | |
| 41 | | | | | | | | | |
| 42 | | | | | | | | | |
| 43 | Very thin (<1/16") fracture with iron oxide stain | | | | | | | | Coring rate 8'/25 min. |
| 44 | BOTTOM OF BORING @ 44' | | | | | | | | |

APPENDIX D

Runoff Volume Computation

$$S = \frac{1000}{CN} - 10 \qquad (1)$$

Where S = maximum pootential difference between direct runoff and storm rainfall (inches).

CN = curve number

$$Q = (P - 0.2S)^2/(P + 0.8S) \qquad (2)$$

Where Q = cumulative direct runoff (inches)

P = cumulative rainfall (inches)

Land area of drainage basin (A) = 31,080,060 sq ft

Impoundment area (B) = 3,245,220 sq ft

Curve number (CN) = 60
from equation (1):

$$S = 6.67$$

# APPENDIX D
## Inflow Volumes for Storms of Different Recurrence Intervals

| | Rainfall Depth (R) (in.) | Q (in.) | Runoff Volume From Land Portion of Drainage Basin $\frac{AQ}{12}$ (ft3) | Rainfall Volume Falling Directly On Impoundment $\frac{BR}{12}$ (ft3) | Total Inflow Volumes (ft3) |
|---|---|---|---|---|---|
| 10-yr | 1.78 | 0.028 | 72,520 | 481,374 | 553,894 |
| 100-yr | 4.40 | 0.970 | 2,512,305 | 1,189,914 | 3,702,219 |
| PMF | 10.5 | 5.31 | 13,752,927 | 2,839,568 | 16,592,495 |
| 1/2 PMF | | | | | 8,296,248 |